APPENDIX E
Provincial Peer Review Comment Record

Provincial Peer Review Comments: Centre Wellington Tier Three Water Budget, Physical Characterization Report

Peer Reviewer	Reviewer Comment #	Reviewer Comment	Response
Dave Rudolph (UW)	1	The concept of a "scoped" study is new for the source water protection work and the projected future water needs in the area is usually a significant factor in assessing the potential level of risk to the water supply in the long term. The Master Water Plan is not available but is there any way to develop an estimate of future water demand for a scenario analysis at least? Do we have a reasonable idea when the longer term water needs for the area would be available to the team? The significance of this work being "scoped" needs to be as clear as possible for the readers.	We agree, the future water demands are important and Matrix will work with Township staff to obtain the best guess of the future water demands for Centre wellington and how those rates will be partitioned amongst the wells. The potential integration with the Long Term water supply strategy is not well known at this point, but will become clear when the project is underway.
Dave Rudolph (UW)	2	Impact of water takings on surface water features may play a significant role in this study and the approach needs to be clear. Groundwater has been extracted for a long time in this area and I was wondering if there is any anecdotal evidence of impact on surface water features such as the drying up of specific wetlands or marshes that could be documented. The classification of the wetland complexes is important for this study as different types of wetlands exist. On P. 12 the point is made relative the PSWs that fens and swamps would be the main focus of the study. In looking at the PSWs that are listed as critical and of interest, many involve marshes as well, which is a bit confusing as it was stated that marshes were not as important to the study. Also, it is also inferred that wetland features other than those on the PSW list might be considered for assessment as well. This designation and the approach that will be used for the overall risk analysis should be as clear as possible.	Based on our review of the data and reports, we are not aware of any changes to surface water features that may be attributed to increases in municipal demand. The wetlands in the area appear to have persisted for decades suggesting the municipal bedrock aquifers are hydraulically separated from nearby surface water features. The wetland complexes in the study area were classified by the MNR or GRCA as swamps, fens, marshes, etc., and in the majority of cases, the complexes are a mixture of wetland types. Quantifying impacts on Provincially Significant Wetlands will involve evaluating the predicted change in fluxes in boundary conditions applied to represent the wetlands. If an interaction is suspected between the groundwater and surface water system and local scale characterization is absent, recommendations will be made to address that data gap with field data collection. If the GRCA has capacity to undertake the field assessment, some field studies may be undertaken at that time.
Dave Rudolph (UW)	3	P. 13 notes that there are significant changes to the Silurian sequence stratigraphy based on new interpretation. There have been changes to the names of different units but it would be valuable for this report to indicate how these "changes" in the geologic conceptual model or rock classifications would impact the hydrogeologic conceptual model. What are the critical differences from the previous conceptual model? It is a bit hard to see the overall significance of these updates in the geologic information.	The thickness, depositional environment and nomenclature of the bedrock units have changed from the previous characterization (i.e., Amabel and Eramosa Formations) to the current characterization (i.e., Goat Island, Eramosa and Gasport Formations). From a hydrogeologic perspective, the previous and current characterization both characterized the bedrock units as thick dolostone units with thin aquitard material in the Fergus area, yet our aim in this project is to link the most up to date geologic understanding with the hydrogeologic data.
Dave Rudolph (UW)	4	Figure 6 has very useful information related to the bedrock topography and the location of buried bedrock valleys. The current version of that figure has so much information on it that is very difficult to see the detail that is referred to in the text. Perhaps an additional figure could be included that just shows the bedrock topography with indication of the valleys that are important to the study for the reader to consider would be useful.	New Figure 7 has been created as suggested to show the bedrock topography and bedrock valley near Fergus and Elora.
Dave Rudolph (UW)	5	It is not clear on Table 7 if these are picks made by the Matrix team or were they derived from other sources. If they came from other sources as well then there should be a reference to those.	Table 7 updated to note the source of the bedrock picks in the Centre Wellington area.
Dave Rudolph (UW)	6	A major challenge will be to assign distributions of K and S for the different units of interest within the simulation domain. Within the rock units the heterogeneity will be significant. How can this uncertainty be minimized? What approaches will be used to assign these parameters considering all of the detailed work that has gone into the geologic model?	Comment is acknowledged and the parameterization of the geologic units will be discussed in detail in the Model Calibration and Water Budget Report. The approach will be to add heterogeneity to the model where it is supported by available data. Insights gained on hydraulic conductivity values where data is available, will be extrapolated outwards where higher quality data is sparse or absent.
Dave Rudolph (UW)	7	P. 36. The overall threat to long term water quality from the numerous sources that have been identified may represent the highest risk to the water supply in both the short and long terms. It might be of value to consider the approach that may be required to assess these risks, which is somewhat unique to this Tier 3 evaluation.	We agree that water quality can limit the operations where treatment represents a constraint; however, the focus of this study is on the water quantity of the area. Commenting on the water quality is outside the scope of this study, aside from assessing water quality as an indicator of water sources (i.e., deep bedrock sources, vs shallow sources).

Dave Rudolph (UW)	8	Within the main production wells, how much is known about the actual production zones along the length of the open holes? Is there some consistency here? This will also be of use when estimating K values from the T estimates. (E.g. P. 44, Table 12. How where the K values calculated?).	Regarding Table 12, the values of K, T, and S are presented as a summary of values which have been calculated in previous historical studies using different types of hydraulic testing data. No new calculations were made for the characterization report. The report text has been updated in Section 4.1 to state "these tests and associated historical estimates of hydraulic parameters are summarized in Table 12, along with references of where the estimates are sourced from".
Dave Rudolph (UW)	9	On P. 39 it is noted that surface water takings are not considered in the study. Is there a potential impact on the surface water features including streams and wetlands that these water takings might cause? I am not sure of the relevance of leaving the surface water takings out of consideration.	Evaluating the impact of these surface water takings on the surface water features falls under the permit to take water process and is not within the scope of this study. The aim of this study is to evaluate how groundwater takings may impact surface water features; however, the locations of the surface water permits were added to the figure and discussion was added as suggested.
Dave Rudolph (UW)	10	There seems to be a reasonable amount of information available related to the performance and regional response of the Middlebrook well through a long production history and extended pumping tests. What information is available on the regional impact of pumping from that well based on this available knowledge and testing? Considering the overall importance of the well in this area, a reasonable summary of the well's regional influence would be valuable information for the reader.	The focus of this project is on evaluating the municipal water supplies in Fergus and Elora, and this includes evaluation of the impact of all permitted water takers on the municipal supplies. The impact of the Middlebrook Well on the groundwater supplies in Elora (and Fergus) is a concern but we feel that it would be inappropriate for us to focus our attention on an individual permit in the study.
Dave Rudolph (UW)	11	What information is available regarding the nature of the vertical hydraulic gradient in the within the study area? Is there much information regarding how hydraulic head changes with depth? The significant flowing artesian conditions within the Middlebrook well are an interesting issue and demonstrate the occurrence of high pressure at depth.	Information on how hydraulic head changes with depth at the high quality municipal monitoring wells are included in Table 13. In these wells the hydraulic head decreases or is similar with depth. The Middlebrook well is the only high quality well which shows artesian conditions, originating from the fractured interval at the bottom of the borehole. Maps were added to highlight the vertical head difference between the overburden and upper bedrock and upper bedrock and lower bedrock in the Study Area, although due to the dip of the bedrock units, water levels that extend into the deep bedrock units in the western part of the study area at and west of Middlebrook are rare.
Dave Rudolph (UW)	12	Is FeFlow going to be employed for the simulations? Will this model permit the groundwater –surface water impacts be accounted for sufficiently to be able to develop a quantitatively assessment?	A FEFLOW model will be constructed, calibrated and applied to make predictions for the Study Area. The model will be calibrated to steady-state and transient groundwater level observations, as well as to available surface water baseflow estimates. This calibration will be sufficient for assessing baseflow reduction and water level decline below Provincially Significant Wetlands at the Risk Assessment stage of the Tier Three project. Additional details on FEFLOW model development and calibration will be provided in a stand alone report.
Hugh Whiteley (UG)	1	I have suggested inclusion in the Characterization Report of specific mention of possible changes in the hydroperiod of PSW's as one of the three environmental effects of water taking. Previous Tier Three Assessments have not been this specific in terms of effects on wetlands and I am not sure if this degree of specificity is included in the workplan for the modelling. I understand that in the Clair Maltby study being done for the City of Guelph the modelling will include representation of waterlevels in at least one wetland so I am encouraged to think this representation of hydroperiod is feasible in currently available modelling. There is no need for resolution of the question of how effects on wetlands will be assessed at this time; this will be addressed in future stages of the study.	Assessment of changes to PSW hydroperiods is not included in the workplan and is outside the scope of analysis for this study. Impacts to PSWs will be assessed following the Technical Rules by simulating the decline of the water table below PSWs. Numerical modelling for the Clair Maltby study is being completed using MIKESHE, a fully integrated groundwater-surface water numerical model, where the interactions between groundwater and surface water can be more fully analyzed.
Hugh Whiteley (UG)	2	There is a lot of concern in the communities in the Study Area of the effect of karst features in the bedrock on groundwater movement and vulnerability of water sources to unexpected effects due to karst features. The term karst is not mentioned in the draft report. The addition of a separate section on karst features and a statement on what is known about their extent and magnitude in the Study Area will proactively answer expected responses from the public. I note the Middlebrook well appears to have its major water-supplying zone in a karst feature.	Matrix added a karst section (2.4.2) to the report as suggested.

Hugh Whiteley (UG)	3	Although I did not mention it in my editorial comments it appears to me that the baseflow separation procedure, as conducted and especially for Irvine Creek, may contain a small component of rapid subsurface runoff that reaches the stream independent of the regional groundwater system. The result will be a slight overestimate in the baseflow data of the amount of recharge entering the regional groundwater system as it is represented by the groundwater model.	Supplementary text has been added to the report clarifying that baseflow includes contributions from a variety of sources, and baseflow values may be higher than the amount of groundwater recharge that is received by the local and regional groundwater flow systems.
Hugh Whiteley (UG)	4	p 1 Section 1 Introduction : ~~describes~~ comprises an overview of the tiered water budget assessment process, a review of the goals and scope +of this project, an overview of relevant background reports and a description of the study team members.	The text has been revised as suggested.
Hugh Whiteley (UG)	5	p 1 Section 1.1 Scoped Tier Three Assessment last para will assess current and future stresses on municipal drinking water sources	The text has been revised as suggested.
Hugh Whiteley (UG)	6	p 3 1.2 Project Goals and objectives line 6 evaluated by reviewing the simulated changes in water levels in the municipal wells , groundwater discharge to coldwater streams and changes in waterlevels (hydroperiod) in PSW's.	Assessment of changes to PSW hydroperiods is not included in the workplan and is outside the scope of analysis for this study. Impacts to PSWs will be assessed following the Technical Rules by simulating the decline of the water table below PSWs. The text has been updated to clarify "..groundwater discharge to coldwater streams and water table decline under "Provincially Significant Wetlands" (PSWs)."
Hugh Whiteley (UG)	7	p 4 2 Physical Setting 2.1 Study Area 2nd para All of the water supply wells are open bedrock boreholes (without casing in the bedrock portion of the borehole) ~~that~~ and were constructed	The text has been simplified to state "All of the water supply wells are completed in bedrock..."
Hugh Whiteley (UG)	8	3rd para ~~often translates to~~ have reduced ~~potential for~~ evapotranspiration ~~(as~~ compared to forested land~~)~~, and where tile-drainage exists on the fields, infiltration is increased and overland runoff reduced compared to undrained fields; recharge to groundwater ~~recharge~~ will be reduced if the increase in amount of infiltrated water diverted to rapid subsurface discharge to the stream from the drained field exceeds the increase in the amount of infiltration on the drained field.~~is also reduced as rain and snow are diverted directly to surface water features~~	The text has been revised as suggested.
Hugh Whiteley (UG)	9	p 7 2.3 Ground surface topography and drainage ; toward the south ~~where~~ elevations decline to 325 m asl along the base of the Grand River valley (Figure 3)	The text has been revised as suggested.
Hugh Whiteley (UG)	10	p 8 Table 2 It would be very helpful to add the Eramosa River at Watson Road (02GA 029) so that the table covers a "flashy" watershed with till-plain soils; a subdued response watershed with mixed soils; and a low response watershed with extensive high-infiltrability soils. accompanying text would explain differences between the three watersheds.	Eramosa at Watson Road added as suggested.
Hugh Whiteley (UG)	11	p 8 and 9 Table 3 As with Table 2 Table 3 would be enhanced by adding the Eramosa which has total streamflow of about 340 mm/y and baseflow of about 250 mm/y and about 70% baseflow.	Eramosa at Watson Road added as suggested.
Hugh Whiteley (UG)	12	Table 3 contains the average annual streamflow yield, baseflow yield (both expressed as mm/year), as well as the proportion of total flow that is considered to be baseflow. The Irvine Creek near Salem gauge produces approximately 100 mm/year more streamflow than Armstrong Mills. This difference is principally due to soil type and topography which together produce higher overland runoff especially in the cooler half of the year in the Irvine watershed. Another difference is the reduced area of wet areas with forest vegetation that reduces annual evapotranspiration on the Irvine.~~, and is due to the Irvine Creek receiving higher amounts of lake effect snowfall caused by proximity to the Great Lakes, and/or the drainage area being more efficient at converting precipitation to streamflow (e.g. better drainage, fewer wetlands)~~. Of the 475 mm/year of streamflow generated by Irvine Creek, only 112 mm/year is estimated to be baseflow.	The text has been revised as suggested.

Hugh Whiteley (UG)	13	Baseflow, also known as dry-weather flow, is, in Southern Ontario, sustained from groundwater discharge. with some minor contribution from releases from surface storage in wetlands The Irvine Creek catchment's baseflow component is estimated to be 25% of total streamflow as compared to 41% on the Armstrong Mills catchment.	The text has been revised as suggested.
Hugh Whiteley (UG)	14	This difference between streamflow patterns in the two watersheds ~~gauges~~ is expected given the surficial geology present in each of the drainage areas and the enhanced groundwater recharge on the Orangeville Moraine area where ground surface topography is hummocky and runoff is reduced. In general, the high proportion of till in the Irvine Creek catchment lead to a runoff-driven system, while the high proportion of sand and gravel deposits upstream of the Armstrong Mills gauge results in a predominantly baseflow driven system for that catchment.	The text has been revised as suggested.
Hugh Whiteley (UG)	15	p 9 last para before increasing in the fall as soilwater storage levels increase, infiltrability decreases, and evapotranspiration rates reduce toward their mid-winter minimum.~~ceases~~	The text has been revised as suggested.
Hugh Whiteley (UG)	16	~~Additionally,while baseflow during July to Sept is similar for both gauges,~~ Baseflow for the Irvine Creek is lower than for Armstrong Mills, especially during the fall, winter, and spring periods. While both have low basefow rates in the summer months the basefow in the Irvine is appreciably lower during droughts - for example the recorded minimum monthly-mean flows for the Irvine for the months of June July and August are only 25% of the flows in the Speed despite the similarity in watershed area.	The text has been revised as suggested.
Hugh Whiteley (UG)	17	p 11 -2.3.4 Wetlands Wetlands are an integral part of groundwater flow systems. ~~They intercept groundwater flow, store precipitation and surface water and slowly release this water to surface water features, groundwater, and the atmosphere.~~ Wetlands are defined as any water body with water saturation in the root zone, at, or above the soil surface, for some time during the year. There are two general types of hydrologic settings in which wetlands occur. Wetlands in Isolated upland depressions with no outlet stream often have waterlevels thare are perched or mounded above the regional watertable. These wetlands provide recharge to the groundwater flow system but are otherwise not connected to the flow system. Wetland features that are perched or mounded above the water table, ~~or isolated from the underlying aquifers~~ are common in the Study Area, but are not a focus of this investigation. The other setting for wetlands are in depressions that intersect the regional watertable. The waterlevel in these wetlands are expressions of the watertable elevation at that location and the hydroperiod of these wetlands reflect the temporal variation in watertable position. Depressions with low-elevation spill locations on their perimeter usually generate intermittent or perennial outflow in an outlet stream. Wetlands in these settings often have a complex spatial and temporal pattern of interaction with the groundwater flow system with both recharge to and discharge from the watertable aquifer being possible although discharge must predominate for any wetland that is the source of a perennial stream.	The text has been revised as suggested.
Hugh Whiteley (UG)	18	p 13 Check sources for possible newer publications of OGS	Recent OGS publications were added as suggested.
Hugh Whiteley (UG)	19	p 16 last par As discussed at the peer-review meeting the breadth of the bedrock depression in the west of the study area is not agreed. There should be recognition of this uncertainty and a decision made whether to narrow the representation to be more like the other buried-valley representations.	Comment acknowledged. There are several wells in this area that corroborate the interpretations we have made, and the data is consistent with a regional scale mapping conducted by the OGS (Gao et al 2006). Reference added to the report.
Hugh Whiteley (UG)	20	p 22 The structure of the bedrock surfaces across the Study Area presented in this report has capitalized on the background data review and interpretations put forth by OGS researc	The text has been revised as suggested.

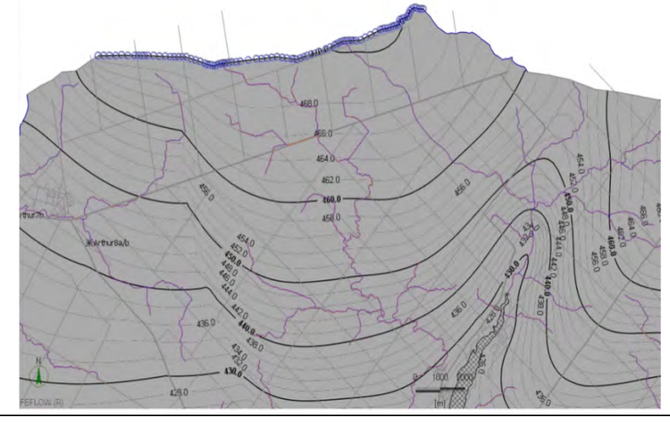
Hugh Whiteley (UG)	21	p 26 There is no mention in the bedrock hydrostratigraphy of the presence or absence of karst conditions in any of the rock layers. The Wellington County community are very conscious of the possibility of karst conditions and the large effect karst features have on groundwater movement. In anticipation of questions from the public I suggest a new subsection dealing specifically with the presence or absence of karst features anywhere in the study area or in the vicinity of the boundary and how this is dealt with in the modelling.	Matrix added a karst section to the report as suggested (2.4.2). The simulation of karst in the future groundwater flow model will be described in the Model Calibration and Water Budget Report.
Hugh Whiteley (UG)	22	p 29 At the well location, the elevation at the top of the well more closely coincides with the water well data. {I don't understand this sentence! - is it that the water-well-data for top-of-well more closely corresponds to model land elevation at the well location ?	Additional text was added to clarify the text.
Hugh Whiteley (UG)	23	p 32 Section 2.6 recharge, the portion of precipitation remaining after water is ~~evaporated,~~ evapotranspired or transferred to streams via overland flow and interflow above the groundwater system. Explanation: evapotranspiration is a comprehensive term and is inclusive of all transfer of liquid water to water vapour in the atmosphere and thus includes both direct evaporation from exposed water surfaces AND water that is transpired by plants and evaporates in the leaf stomata.	The text has been revised as suggested.
Hugh Whiteley (UG)	24	p 34 end of section 2.6.1.1 i suggest the following be added as a final comment. The contour mapping of watertable location should not be interpreted as suggesting actual flowpath direction of water below the watertable in the watertable aquifer. In upland locations the actual flow direction may be vertically downward with little or no lateral (i.e. horizontal) flow near the watertable. Similarly in the vicinity of springs or seeps actual flow direction may be principally vertically upward. Along extended slopes the contours do indicate flow direction.	As suggested, we added a closing paragraph to note: "The contour mapping of the water table elevation at any given location does not illustrate the vertical flow within an aquifer. In some areas, there may be significant vertical flow alongside the horizontal flow through the aquifer, which is not represented on the two-dimensional contour map."
Hugh Whiteley (UG)	25	Figure 5 The legend should somehow state that the bedrock formation shown is the bedrock surface layer	The legend has been updated to clarify that the unit shown is the uppermost bedrock unit.
Hugh Whiteley (UG)	26	Peer Review Meeting. Suggest looking at the 1970s Steibel thesis (Masters, UW) which contains hydraulic conductivity values north of Rockwood. They did a lot of shallow well drilling and there was not a distinguishing K difference between the uppper and Guelph Formation and the bottom of the overlying sediments.	We have tried to locate the thesis but have not found it yet; we will continue to try to locate it.
Hugh Whiteley (UG)	27	Peer Review Meeting. The team should look at the G360 water age data in an annual report from a few years ago.	Matrix has been in touch with G360 to locate the relevant articles/ report but have not successfully located it yet. We will continue to search for this information.
Rob Schincariol (UWO)	1	Section 1.2. Page 4. Agreed. I have raised issues in this report, as have other peer reviewers at the June 26 Peer Review Meeting, regarding stratigraphic / hydrostratigraphic characterization, and defined study area / possible model boundary conditions. It is clear to me that as you move forward these issues will be appropriately addressed as new data and preliminary model assessments take place.	Yes, we will document the justification for the selection of the Study Area and the model boundary in the Model Development and Calibration report.
Rob Schincariol (UWO)	2	Section 2.3.1.1. Page 8. Even though the gauges on the main Grand River are influenced by the Shand Dam operations, would they not be useful as the flows could be naturalized as operations at Shand should be well known?	The reviewer is correct, main Grand River flows can be naturalized to remove the effects of Shand Dam. The original text failed to fully describe that the majority of streamflow measured at the West Montrose gauge (drainage area of 1,170 km^2), is not generated within the Study Area, but rather, is generated upstream of Shand Dam (Dufferin County). As such, analysis of this gauge data would not inform on the composition of streamflow (overland runoff vs baseflow) generated within the Study Area. Supplementary text added to report to clarify reasoning for excluding West Montrose gauge.
Rob Schincariol (UWO)	3	Section 2.5.1. Page 22. editorial - "The provide measures the ..."	The sentence has been revised to clarify that "The probe measures the gamma radiation…"

Rob Schincariol (UWO)	4	Section 2.5.1.2. Page 25. Your two sentences 'Fracturing or weathering ..." and "For example, a mud-rich ..." confuse the science rather than make it clearer. Fracturing and weathering generally only increases the hydraulic conductivity unless you include secondary mineral precipitation / alterations (e.g. dolomitization). True if you weather a unit and decrease its thickness you would decrease T. However, you should clarify how this comes about and is related to the study area, if you mention it. For example, at the Peer Review meeting it was stated by Brunton (I believe) that the Goat Island had quite a bit of time exposed to surficial weathering before the Guelph formation was deposited - so you can have significant variations in thickness due to erosion. Do you not have your 'examples' reversed or am I missing something? Don't you really mean to say 'A mud-rich limestone with few fractures may behave as a poor aquifer, while a well-fractured shale may behave as a poor aquitard'?	Comment acknowledged and the discussion of fracturing and the impact on hydraulic conductivity was removed. The intent was to note that shale (often considered an aquitard) can behave as a weak aquifer when the unit is well fractured (i.e., the upper portion of the weathered Queenston shale bedrock in the Brampton area is used for domestic water supply). Conversely, dolostone (often considered an aquifer) may behave as an aquitard when fine-grained, competent and unfractured (as in the case of the Vinemount formation). Text was removed to avoid further confusion.
Rob Schincariol (UWO)	5	Section 2.5.1.2. Page 26. ~~, suggesting the lower member may have a higher hydraulic conductivity value than the overlying member. This trend in hydraulic conductivity values assumes that the degree of fracturing in both members is the same, which may not be the case in all areas.~~ This assumption is weak and does not match your approach of simulating fracture flow as an equivalent porous media (EPM). If K is higher then really the degree of fracturing must be greater unless you consider the unit to have such a high inter-granular K that fracturing is of less importance? Considering bedrock, and presented with only the finding that there is a granular fining upward from the lower member to the upper member should not, defacto, mean the lower member will have a higher hydraulic conductivity. It is entirely possible the upper member could be more highly fractured than the lower member given the tectonic stress state and finer nature. I would refrain from making these correlations of fining upward to K reductions without presenting other hydraulic or geologic (i.e. fracture density) data.	Agreed. Our original intent was to correlate the inter-granular K with the bulk K in the absence of fracturing; the text has been removed as suggested to clarify the text.
Rob Schincariol (UWO)	6	Section 2.5.1.2. Page 26. Okay now you have added some additional information on the geology of the units (i.e. one lagoonal, one reefal). Still, your discussion could be interpreted as stating that EPM K is independent on the degree of fracturing. For clarity you could just delete the last part of the previous paragraph and modify the last sentence in this paragraph to simply state: "This trend is based on the grain-size and nature of the carbonate bedrock, and does not consider the degree of fracturing of the two members" It is very different to state one is not considering the degree of fracturing versus saying it is 'independent' of the degree of fracturing.	Yes, agreed. Thanks for the comment and helping clarify the text. The text was revised as suggested.
Rob Schincariol (UWO)	7	Section 2.5.2.1. Page 28. Okay seems good but the only question I would raise is are there any hydrostratigraphic layers that are present in the study area that were not identified in the Burt and Dodge or Bajc and Shirota studies?	No, we feel the OGS defined hydrostratigraphic layers cover all the glacial and interglacial overburden units present across the Study Area.
Rob Schincariol (UWO)	8	Section 2.5.3. Page 29. You explain here why some of the boreholes may show up above or below ground surface (i.e. offsets). During the Peer Review Meeting it was mentioned by others how there is often a mismatch between bedrock lithology in some of your boreholes and your interpreted bedrock surfaces / interfaces. This was particularly evident with some of the high quality wells. I think it would be beneficial to repeat this discussion on reasons for borehole-surface mismatches in the bedrock interpretation section.	Text updated in Section 2.5.3 to clarify why there may be a mismatch between the borehole geology and the geologic formations illustrated on the cross-section.

Rob Schincariol (UWO)	9	Section 2.5.3.2. Page 31. For cross section C-C', and other cross sections, the bedrock units all seem to be 'pushed up' around borehole E1. Is this an interpretation or presentation error? What would be the mechanism to move all of the units, even a slight upward deflection in the Cabot head fm as shown. I would expect you could see this regionally with tectonic stresses but not at a local scale.	Cross-section C-C, illustrated the interpreted bedrock surfaces that were generated using picks interpreted by Matrix and Frank Brunton. The top surface of the Niagara Falls member of the Goat Island Formation was picked by F. Brunton to rise at Well E1 and MW2-11 to an elevation of approximately 331.8 masl, and fall to lower elevations at surrounding boreholes. The actual extent of the rise in the bedrock at these wells is magnified by the vertical exaggeration of the cross-section. Boreholes with larger offset distances were removed from the cross-sections to avoid confusion.
Rob Schincariol (UWO)	10	Section 2.5.3.3. Page 31. Did they really screen across the Ancaster and Niagara Fals Mbr's for MW1-5. As this well is 375 M off section I can understand that you simply placed the screened interval at the measured depth, but it could be confusing to some readers. Could include this screened interval in your discussion of how offsets affect locations on cross sections.	Correct, MW1-12 is shown as 375m off section and this well interval is interpreted to be screened solely within the Niagara Falls Member of the Goat Island Formation. It appears to be screened across the Ancaster and Niagara members due to the offset of the well from the cross-section. Wells with larger offsets that appear to have geologic units that do not align with the surfaces illustrated on the section have been removed to avoid confusion. Text was also added to Section 2.5.3 to clarify.
Rob Schincariol (UWO)	11	Section 2.5.3.3. Page 31. Did you inadvertently 'push up' the interface on the cross-section so it matched your discussion? E1 is 48.7 m off section, you state that it extends into the Gasport so you make an upward deflection in the gasport line so it shows this on Figure 12. Yet really at the location of your cross section it may not actually move into the gasport. If this is the case, for consistency, you should maintain unit thickness and not modify sections to match offset boreholes.	No, the sections that are illustrated show the surfaces as they were generated along the cross-section line and were not modified. Some boreholes that were projected larger distances off the cross-section were removed to avoid confusion.
Rob Schincariol (UWO)	12	Section 2.6. Page 32. Topographic slope will influence infiltration even if not 'extremely steep' .. recommend just removing the '(if extremely steep)' statement.	The text has been removed as suggested.
Rob Schincariol (UWO)	13	Section 2.6.1.1. Page 33. Agreed ... but how did you determine the elevation of the seepage face?	We did not constrain the water table elevation along the gorge and apply control points representative of the seepage face. Instead, we choose to simply interpolate the water levels on either side of the gorge and make the assumption that the seepage face would lie where the water level intersected the side of the gorge. The water level mapping is considered suitable at a regional scale, and may not be representative at the local scale (i.e., at the seepage face of the gorge).
Rob Schincariol (UWO)	14	Section 2.6.1.1. Page 33. You should tell the reader the consistent process you used to identify these points for exclusion. OR At least tell them such a process was used.	The process applied to flag and remove the erroneous data points was added to Section 2.6.1.1 as suggested.
Rob Schincariol (UWO)	15	Section 2.6.1.1. Page 33. From permitted and non-permitted takers. In fact in section 3.3.5.1 you discuss non-permitted takings and tell us you will take these into consideration in an 'aggregate' sense.	The text has been revised to include "...from permitted and non-permitted water takers..."
Rob Schincariol (UWO)	16	Section 2.6.1.2. Page 34. A major concern is the delineation, and intended use, of the 'Study Area' boundaries. One would assume the Study Area boundaries will form the numerical model boundaries. However, as currently defined, there are very few hydraulic or watershed based boundary conditions associated with the Study Area boundaries. Figures 15 and 16 do show some justification for boundaries in the NE and SE. However elsewhere it appears low quality wells will define specified head boundary conditions. You need to better justify your choice of Study Area boundaries in preparation for the defense of model boundary conditions. Presenting a larger map area would help reviewers see hydraulic conditions beyond the proposed study area.	Comment acknowledged. The extent of figure 1 was expanded further to illustrate the broader area and the surface water features. The justification for the model boundaries and the Study Area will be more explicitly outlined in the Model Calibration and Water Budget Report.
Rob Schincariol (UWO)	17	Section 2.6.1.2. Page 34. see previous comment 'permitted water takers'.	The text has been revised to include "...from permitted and non-permitted water takers..."
Rob Schincariol (UWO)	18	Section 2.6.1.2. Page 34. same as previous comment	The text has been revised as suggested.

Rob Schincariol (UWO)	19	Section 2.6.1.3. Page 35. Were no bedrock wells considered 'anomalous' (i.e. you discussed the removal of overburden and interface anomalous wells)?	The report has been updated to note that 33 bedrock wells were removed as the water levels appeared anomalous.
Rob Schincariol (UWO)	20	Section 2.6.1.3. Page 35. Continuing on with my concerns with respect to Study Area boundary delineations. There are no natural hydraulic or watershed / basin scale divides associated with the Lower Guelph, Goat Island, and Gasport Formations (i.e. Figure 17). In the NW, W, and SW area of the Study Area there is no groundwater head data available (and thus you have not extended the equipotential surface in these areas). You have very limited data in the north. Thus it seems problematic at this point how you will be able to assign model boundary conditions within your defined Study Area boundary conditions for the bedrock units, which are of primary concern, in this study.	Yes we understand your concerns with the application of model boundary conditions in the area to the northwest as there are few wells in that area that extend into the deep bedrock units. Matrix will outline the rationale for the selection of model boundary conditions in the future Model Calibration and Water Budget Report (groundwater level elevations have been mapped on a regional scale and this mapping will be used to help supplement the existing water well data).
Rob Schincariol (UWO)	21	Section 2.6.1.3. Page 35. Again permitted and non-permitted pumping will affect the surface.	The text has been revised to include "...permitted and non-permitted pumping."
Rob Schincariol (UWO)	22	Section 3.3. Page 39. How would a member of the public or those without hydrogeological training interpret this? If you could it would be good to add a sentence stating how this 'reasonable period of time' is determined or defined.	We agree. The sentence was updated to state that consumptive water uses is water removed from a source and not directly returned to the same source to help clarify.
Rob Schincariol (UWO)	23	Section 3.3.4. Page 42. Your process of explaining how you achieved the Consumptive Rates listed in Table 11, and citing your AquaResources 2009 report (Table 3.5 I assume?), does not allow a reader to understand how you arrived at your Consumptive Rates in Table 11. One cannot take the consumptive factors listed in Table 3.5 (AquaResources 2009) and move your max. permitted rates in Table 11 to Consumptive Rates. I assume this may be due to the fact some of the sources are ponds which you are not considering? For example, the Aquaculture factor is listed as 0.005 yet your 10,143 to 4779 conversion does not follow this; same with golf course irrigation - consumptive factor is listed as 0.7 yet the consumptive rate is only 52 m3/day when the max. permitted rate is 2261 m3/day in Table 11.	The consumptive use factors are applied to the Actual Reported Takings from the WTRS and we only use the Maximum Permitted Takings in the calculation where reported takings from the WTRS are unavailable. In this project, the Maximum Permitted taking was only used to estimate consumptive use for one permit. In the example you provided, the aquaculture permit is assumed to be 100% consumptive - as the takings are drawing from wells and discharging to the surface water body. It may be the case that if an aquaculture permit source is surface water, then the consumptive use is only 15%. WTRS values were appended to Appendix C to clarify the water demand estimates.
Rob Schincariol (UWO)	24	Section 3.3.5. Page 42. Nestle, I assume, purchased the property not just the well? One really does not 'purchase' a well in Canada. Would not a better way to say this be "In 2017 Nestle Waters Canada (Nestle) purchased the property and took ownership of the well".	Agreed. The text was revised to say "In 2017, Nestle Waters Canada (Nestle) purchased the property from the Middlebrook Water Company and took ownership of the well.
Rob Schincariol (UWO)	25	Section 4.1. Table 12. Was the S actually reported to be "0.0" for some tests on OW2 and OW3? OR is this an artifact of you rounding to one decimal place? I am all for significant figures but 0.0 is a pretty definitive term in hydraulics. If number was very small report as an exponent (e.g. 10-3).	This was an artifact of rounding. These very low values have now been updated to scientific notation in Table 12.
Rob Schincariol (UWO)	26	Section 4.2.3. Page 47. A single detection in a bedrock well can be considered a significant event and an indication of ongoing contamination. Atherholt et al. 2015 (Ground Water Monitoring and Remediation) in an extensive 10 year study involving >78,000 wells, looked at the effect of repeat sampling on coliform bacteria detection rates. They found for FC/EC bacteria 21 and 68 samples, respectively, would be required to reach the 50% and 90% population detection rates. They recommended owners of wells located in bedrock follow the USEPA recommendation of sampling once a month tor 12 or more months. I mention this as your discussions inclusion of 'on one occasion' could give the public a false sense of security. However, as noted by Atherholt, and USEPA guidance, it is actually very difficult to capture bacteria / viruses in single sampling events - especially in bedrock aquifers.	Comment acknowledged. The sentence "Each of these wells only detected a virus on one occasion during the study (Allen et al. 2017)." was removed.

Provincial Peer Review Comments: Centre Wellington Tier Three Water Budget, Groundwater Flow Model Development and Calibration Report

Peer Reviewer	Reviewer Comment #	Reviewer Comment	Response
Dave Rudolph (UW)	1	The document is very well-written and clearly presented. It would be of benefit to the reader to explain what is meant by "Scoped" assessment. It is not obvious from the text and would be useful to understanding the overall context of the work.	Text updated to the report as suggested to clarify.
Dave Rudolph (UW)	2	P.3. There have been many previous modeling projects undertaken in the vicinity of the study site and they are briefly explained in the text. It would be of value to expand somewhat on why these previous models could not be used for the purposes of the current study and what specifically had to be included/improved upon with this next generation of modeling for this site.	Text updated in Section 1.3 as suggested to clarify why the previous models were not applied.
Dave Rudolph (UW)	3	P. 11 and 13. The recharge boundary condition is explained to be derived from the results of the Tier 2 GAWSER modeling results. This is a logical approach but it should be justified with some additional detail as to why it was not necessary to recalibrate the GAWSER model for the current model domain. It does appear that recharge was modified to some degree during the calibration process. It is also not clear how the recharge boundary condition was applied for the transient conditions. This just needs a brief explanation.	Text was updated in the report to note why the GAWSER model was not recalibrated in the Tier Two (no substantial changes in land use in the Irvine River catchment where we have gauge data), and the long term average annual recharge applied in the steady-state model was applied in the transient model.
Dave Rudolph (UW)	4	It would be insightful to remind the reader what climatic data (location of the MET stations) were used to develop the GAWSER recharge simulations. This would provide an additional degree of confidence in the recharge estimates.	Descriptions of the source of the climate data were added to the report as suggested.
Dave Rudolph (UW)	5	P. 11,12. The lateral boundary conditions are explained in some detail. It is unclear if the assigned boundary conditions are assumed to be the same throughout the entire thickness of the model (i.e. uniform through the overburden and bedrock units below a given surface point). It seems from the text that varying specified head values were assigned to different depths based on data from local monitoring wells. This could be explained in a bit more detail. Along the northern boundary, in the vicinity of the Grand River, a large region of no flow was assigned as the boundary conditions. Was this assigned through the entire thickness of the model sequence? It is not obvious how thick the overburden is here but it appears as thought the topography is fairly flat. The existence of the Grand River will no doubt influence the shallow groundwater flow system but it is not as obvious that it would have a similar influence on the deep bedrock units. Perhaps there is hydraulic head data that would justify the assignment of a no flow boundary condition through the rock units in this portion of the model domain. This justification should be provided as there may be significant groundwater inflow along that segment that would not be accommodated with the zero flux condition in the rock.	Figures 4 and 5 and Section 3.71 of the report were updated to illustrate and describe which layers in the model the boundary conditions are applied on to help clarify where the flow is coming in/ out of the model domain. Regarding the interpretation of interpreted groundwater flow directions along the northeastern boundary of the model domain, we believe that there is a no-flow boundary in this area as groundwater flows into the Grand River. We acknowledge the uncertainty in this interpretation; however based on the water budget completed for the area, there is little inflow through lateral boundary conditions and we expect adding boundary conditions to allow water into the model domain in this area will not markedly change the overall water budget in this area. See image below which illustrates the flow into the model in this area. 

Dave Rudolph (UW)	6	P. 18. The storativity range is stated to be between 5.2x10-4 to 6.3. Likely a typo.	The value of 6.3 was referenced in Terraqua report, but removed to avoid confusion.
Dave Rudolph (UW)	7	Were the domestic wells considered to be fully consumptive? If so, this should be briefly justified although the overall extraction is relatively low so it is not a major factor.	Text updated in Section 3.7.4.2 to note the takings were assumed to be fully consumptive.
Dave Rudolph (UW)	8	Is it possible to indicate the difference between the water entering the domain from the ground surface as compared to how much is flowing in from the lateral boundaries?	A water budget section was added (Section 6) to illustrate the water moving in from the lateral boundary conditions as opposed to flow in from above (i.e., recharge).
Dave Rudolph (UW)	9	In examining the hydrograph for Well E1, it appears that levels steadily rose from 2006 to ~ 2010 and then showed a gradual decline. It would appear that the average extraction rates did not change at all during this time period although they were variable. Is there a physical explanation for the progressive lowering of groundwater levels in this well (~10 M) over this time period and an indication of what significance this may have for regional groundwater management in the long term?	Comment is acknowledged and additional reviewed of the water levels in the well and the area is being assessed on an annual basis as part of the Permit to take Water evaluation. The long term sustainability of the water supply is being evaluated in the Risk Assessment so these types of trends could be assessed in greater detail in the next phase of the project. (No updates made to the report)
Dave Rudolph (UW)	10	The transient simulations are all very good except for the magnitude match for MW4A and B. The text mentions that this may be a storage coefficient issue. Does this influence the overall assessment of the groundwater flow system? It just seems out of place compared to the other wells although it could just be an artifact of the model and not matter much anyway	Additional text was added to the report to explain the discrepancy between the simulated and observed values at MW4-12 and the implications of the under prediction of drawdown at this well.
Dave Rudolph (UW)	11	It would be very valuable to get access to the long term Middlebrook well pumping test to evaluate potential impact on surface water levels from pumping deep rock formations. The role of the overburden in shielding the surface water system from deep rock pumping should be assessed in detail and the model provides an excellent tool to do so.	Additional text was added to the report to evaluate the potential impact associated with a 30 day taking at the Middlebrook Well in the bedrock and surface water features.
Hugh Whiteley (UG)	1	As I said at the meeting the report should clearly identify the situation as being a study area with appreciable inputs of groundwater through parts of the boundary and appreciable outputs through other parts of the boundary. **A small table of average annual inputs and outputs to the groundwater system within the study boundary could present this information**. As usual inputs would be entry flows through the control volume sides and recharge to the water table. Outputs would be outflows through the control volume sides, groundwater discharged to baseflow in outlet streams and (likely insignificant) groundwater discharged through evaporation in areas where the .water table is less than 1 m from the ground surface. Expressing all quantities in annual amounts in mm (over the project area) would allow easy comparison with the usual single input i.e.- annual recharge.	A water budget section was added to the report to note the groundwater inflows and outflows within the model domain as suggested.
Hugh Whiteley (UG)	2	A second quick point is that I would like to see sometime, perhaps not before this stage report is finished, a comparison between the project-area-model results for annual flows into and out of the study area sides and the flows through the location of the project-model sides obtained by projecting the project-model-area sides into the full (Tier Two) watershed-scale model for the Grand and obtaining the flows through this plane within the bigger Tier Two model. I am looking for order-of-magnitude checks and general correspondence of flow-direction (in or out) and not close correspondence of the two sets of flows.	A comparison of the groundwater water budget for the Tier Three study area, and the Tier Two study area was added to the report as requested into the Water Budget section of the report.

Hugh Whiteley (UG)	3	**Consideration of karsh features in the description of the geological setting** The presence of a karst feature in the Middlebrook well is mentioned in the report without identification of “karst”. It would be helpful to do a brief scan of available well profiles of the Elora and Fergus wells to see if any conspicuous karst features were observed in any of the wells and, if so, add a brief note about any appreciable karst features to the description of these wells. The report acknowledges the extensive work of Frank Brunton and associates on the characterization of the Silurian bedrock of the area. This gives guidance on identification of karst features and the stratigraphic and areal variation in intensity and size of karst features. Given the extra scrutiny this report will receive from the public, and the attention that has been given to karst features of the bedrock in the Rockwood area in several past and current investigations it would be beneficial for this report to have a brief section on karst features added as a footnote to Table 1. The section would specify which stratigraphic units, and which areal locations within the study area, show appreciable karst features. There should also be an indication of where, on the spectrum from no karst features to large caverns and underground rivers, the sizes, intensity and continuity of karst features lie for those locations with any appreciable karst features. To compliment this descriptive foot note about the presence of karst features in the study area the introductory paragraph of 3.1.1 should be expanded to explain that the EPM modelling approach has been used successfully to represent karst features as part of the distributed fractures present in portions of the Silurian bedrock of the Rockwood area in the Guelph Eramosa Tier Three model.	A new section was added to the report in Section 2 regarding karst features present at surface and in borehole logs as suggested.
Hugh Whiteley (UG)	4	**Checks on order-of-magnitude of bedrock flows entering and leaving the study area** As mentioned in earlier comments this study area is distinctive in having appreciable flux of groundwater entering the control volume through the vertical sides and equally appreciable flows leaving the control volume. If it was feasible it would be reassuring to check that the annual volumes of inflow and outflow in the bedrock as represented in the steady-state model results are of the same order of magnitude as was represented in the Tier Two model.	A water budget section was added to the report to describe the flow in/out through the boundary conditions as compared to the surface of the model (i.e., recharge).
Hugh Whiteley (UG)	5	General text changes the SI symbol for year is y and for day d so units are mm/y not mm/year and m^3/d not m^3/day	Text updated as suggested.
Hugh Whiteley (UG)	6	3.3 last para line 6 ad 7 suggested change **The portions of the model-domain boundary oriented perpendicular to hydraulic head contours were given the boundary condition of no-cross-boundary-flow.**	Text updated.
Hugh Whiteley (UG)	7	3.7.2.1 Explain why the Woolwich reservoir level is not assigned based on GRCA data .	The stage elevation for the Woolwich Reservoir was derived using data from the GRCA website on their reservoir elevation data (internal miscommunication). Text was updated to note both reservoir water levels were obtained from GRCA datasets.

Hugh Whiteley (UG)	8	3.7.2.3 In the future modelling any large wetland with a perennial stream at its outlet should be given special attention to confirm groundwater discharge into the wetland is modelled.	Comment is acknowledged; no changes made to the text.
Hugh Whiteley (UG)	9	3.7.3 first par last sentence suggested change **The highest intensity of recharge occurs in areas of high relief where coarse-grained sediments are mapped at surface.** Second par 2nd sentence suggested change **GAWSER is a subwatershed-scale, deterministic, lumped-parameter, transient-mode, streamflow-generation model. Model inputs are precipitation and air temperature, outputs include streamflow hydrographs of stormflow and baseflow components. Recharge to groundwater is one of the internal fluxes determined by the model (Schroeter and Associates 2004)**	Text updated as suggested
Hugh Whiteley (UG)	10	4.3 first par second sentence Suggested change **The calibration data set comprised all higher quality data across the model domain as well as all the lower class data available.**	Text updated.
Hugh Whiteley (UG)	11	4.3.1 first sentence Suggested change **Baseflow is the dry-weather portion of streamflow. Groundwater discharging to stream channels is the predominant source of baseflow. Supplemental sources of baseflow are: managed discharge from reservoirs, discharge from Water Resource Recovery Facilities (formerly called wastewater treatment plants) and flow diversions from outside the watershed.**	Text updated as suggested.
Hugh Whiteley (UG)	12	P 25 4th bullet point……range. Suggested new second sentence **The private well has an open (uncased) section and thus the attribution of a waterlevel to a specific unit is uncertain so the discrepancy is considered acceptable.**	Text updated as suggested.
Hugh Whiteley (UG)	13	5.2.2.1 I suggest leaving out the sentence **"The general groundwater flow direction is from north to the south with some flow to the west toward the Conestogo River."** Explanation: Contours of hydraulic head in the overburden are not reliable indictors of flow direction in areas where flow is mainly vertical in the overburden. Furhermore, in areas where there is lateral flow in the overburden, fine-scale flow to local streams is not captured by the scale of modelling done here.	Agree with the comment. Text omitted as suggested.
Hugh Whiteley (UG)	14	5.2.2.2 2nd sentence Suggested change **The lateral-flow gradients in the upper bedrock (Guelph formation) are similar to lateral gradients in the shallow overburden. Flow direction is from northeast to southwest toward the Grand River.**	Text updated as suggested.
Rob Schincariol (UWO)	1	As detailed on page 34 there are significant issues with the modelled versus observed match at pumping well F1. These issues are not discussed in the report, in fact the report comments the response 'are well simulated'. It is not evident what the issue is here as the response mismatches are inconsistent. There could be something irregular with the transducer data, or pumping rate, or a model conceptualization problem in the vicinity of the well. What is clear is that these issues need to be clearly discussed in the report.	The observed well data for Well F4 was erroneously plotted onto the Well F1 chart. The observed data points were updated on the hydrograph and show better agreement with the model simulated results.

Rob Schincariol (UWO)	2	I have not commented, on the pdf, on the fairly significant mismatches in the transient response calibration at high quality MW 4a, 4b. This is because the transient, and steady state, matches to high quality monitoring targets are quite good for other high quality targets. The steady state match at MW 4a, 4b are within the observed range of water levels, with the modelled value at MW 4a being on the conservative side (i.e. at low end of observed range). However, the transient match at MW 4a, at large pumping rates, underestimates drawdown somewhat, while the match at lower pumping rates (17-Sept-12 to 15-Oct-12) follows the average drawdown. Given trends are matched, and means fairly represented, I do not feel any model changes are required to address these mismatches. In fact, while small local changes in hydrogeologic parameters around MW 4 could make the model fit appear better, localized changes could negatively affect model performance under different stress conditions.	Comment is acknowledged (no changes made to the model or report).
Rob Schincariol (UWO)	3	in keeping with the goal of clearly communicating model uncertainty, including the residual plots as shown at the Peer Review Meeting (March 29th), could be helpful. The Overburden, Guelph Formation, and Gasport Formation residuals show a fairly uniform distribution of over and under prediction. Residuals in the areas of the wells are dominated by over prediction which conveys a conservative balance. Separating out high quality well residuals would communicate large residuals are usually associated with lower quality data.	Thanks for the feedback; residual plots will be provided in the revised report in an appendix.
Rob Schincariol (UWO)	4	Page 3 - Cross-Out	Text updated as suggested.
Rob Schincariol (UWO)	5	Page 4 - Inserted Text: geology	Text updated as suggested.
Rob Schincariol (UWO)	6	Page 8 - As discussed at the Peer Review meeting, you could discuss the balance between the size of the model study area and the need for refinement in the critical zones (i.e. wells). Encompassing a larger and larger study area will not necessarily result in a 'better' model. You know this and it is up to you if you want to communicate this to the public.	Additional text was added to the document in the newly added data gaps section to note that our confidence in the model predictions outside of the areas with high quality data is lower than predictions made at the municipal wells.
Rob Schincariol (UWO)	7	Page 9 - That is a pretty large range of ages. Could consider putting an age on each well.	Text updated as suggested.
Rob Schincariol (UWO)	8	Page 10 - conceptual models?	Text updated as suggested.
Rob Schincariol (UWO)	9	Page 10 - Why not use full first name? You use 'Elizabeth's' in next sentence.	Text updated as suggested.
Rob Schincariol (UWO)	10	Page 11 - Cross-Out	Text updated as suggested.
Rob Schincariol (UWO)	11	Page 13 - Not sure 'impractical' is the best word. To me it implies that it could be made practical if say the budget was larger. Especially when you added 'considerable computational effort' to the sentence. How about something like "infeasible" instead?	Text updated as suggested.
Rob Schincariol (UWO)	12	Page 13 - You already said this in last paragraph.	Text updated as suggested.

Rob Schincariol (UWO)	13	Page 13 - adequately? Again choice of words. I consider 'adequate' to be just 'passing' the requirements. Maybe 'reasonable' as you use elsewhere.	Text updated as suggested.
Rob Schincariol (UWO)	14	Page 13 - see you are 'closely' aligning with observed values NOT 'adequately' aligning with observed values.	Text updated as suggested.
Rob Schincariol (UWO)	15	Page 13 - Inserted Text: were	Text updated as suggested.
Rob Schincariol (UWO)	16	Page 14 - By adding 'cross-boundary' to this you may be trying to make it more clear to the public. However, you make it confusing from a technical perspective. What is a 'no cross-boundary flow boundary condition'? I would suggest just sticking with the standard terminology - a no groundwater flow boundary condition.	Text updated as suggested to "No-flow boundary condition" to clarify
Rob Schincariol (UWO)	17	Page 15 - Highlight	Text updated as suggested.
Rob Schincariol (UWO)	18	Page 15 - This sentence really repeats what you just said in the last sentence.	Text updated as suggested to merge with previous sentence to avoid repetition.
Rob Schincariol (UWO)	19	Page 15 - This figure really does not convey any information other than mesh is so fine in areas such as the streams it cannot be seen. If you wanted to show features of the mesh you could give Figure 2 with selected blow up section (i.e. circles) where streams are and wells and regular mesh areas.).	We agree. The figure was updated as suggested.
Rob Schincariol (UWO)	20	Page 16 - Cross-Out	Text updated as suggested.
Rob Schincariol (UWO)	21	Page 17 - you just said 0.2 m in last sentence?	Text updated as suggested.
Rob Schincariol (UWO)	22	Page 18 - On Figure 4 you label the boundaries "River, Creek, and Wetland Boudary Conditions". You should be labelling as per your previous discussion (i.e. Head-dependent or constant head). As it is now your figure does not tell us what boundary conditions you imposed on these features. Same with Figure 5.	We agree. The figure and legend were updated as suggested to clarify the boundary conditions applied.
Rob Schincariol (UWO)	23	Page 21 - sentence needs editing 'most recent and representative taking data'? You should also give the date of the data base used. Okay - it is in the table. Perhaps reference the table again after 'most recent'.	Text updated as suggested.
Rob Schincariol (UWO)	24	Page 23 - How was the 3 km size determined? Some reasoning for this size should be included.	Text updated to clarify that 3 km was selected as the area where agricultural takings may impact the water level in a municipal well.
Rob Schincariol (UWO)	25	Page 25 - 6.3??	Value was reported in the Terraqua Pumping Test report, but may be erroneous. The value was omitted.
Rob Schincariol (UWO)	26	Page 28 - Do you mean + or - 5 m or + or - 2.5 m? As written I would interpret it as + or - 2.5 m. In your following discussion on RMS you do state a + or - 5 m acceptable error. Be consistent.	Text updated as suggested.

Rob Schincariol (UWO)	27	Page 32 - place label on offset line so it is clear on figure it is 10 m.	Figure updated as suggested.
Rob Schincariol (UWO)	28	Page 32 - You focus the Figure 11 discussion on the lower quality wells. However, you do plot the high quality wells on Figure 11 and these should be discussed as it presents nice companion to Figure 10. If I zoom in on overburden 1:1 line, all of the high quality monitoring points fall directly on the 1:1 line. If I zoom in on the bedrock 1:1 line all high quality wells fall within your 10 m offset and there is an even scatter about the line. Basically why don't you create a separate 1:1 plot for just the high quality data and discuss it along with Figure 10?	We chose not to create a steady-state scatterplot for the higher quality wells as the majority of these wells lie in close proximity to pumping wells and their water levels are highly variable and influenced by the pumping rates. As such, we do not see a true "steady state" condition in these wells as the scatter in water levels over time is due to cycling of the wells on and off. We felt illustrating the variation in pumping (Figure 10) was more informative for the reader.
Rob Schincariol (UWO)	29	Page 34 - Your description is not what I see from Figure 12b for F1. There are clearly issues with the F1 model response that are not being discussed. This is unfortunate as the fit to other transient data is quite good. ** From 17-Sep-12 to 01-Oct-12 when the Fergus well is pumping and the Elora well is off the model overestimates drawdown by ~ 10m. During the same period when the Fergus wells are pumping at a much lower rate and the Elora wells are on the model underestimates drawdown by ~ 10 m. ** From 01-Oct-12 to 08-Oct-12 we have a period of relatively consistent Fergus and Elora pumping. However, now the model overestimates drawdown by ~ 20m. ** From 15-Oct-12 when the Fergus well is off the model derived drawdown recovers, however the observed water level does not, probably because it was not responding to the lower rate of pumping previously anyway. However, when the Fergus well is then pumped at a high rate the model and observed drawdowns closely match. ** From 22-Oct-12 with a similar high rate of pumping after a shutdown period, and Elora pumping at approximately the same variable rate as it was previously, the model match is not as good as during the previous period (10m under estimate). Clearly something is either wrong with the pressure transducer, pumping rates could be wrong, or something is wrong with the model conceptualization in the area of the F1 well.	The observed well data for Well F4 was erroneously plotted onto the Well F1 chart. The observed data points were updated on the hydrograph and show better agreement with the model simulated results.
Rob Schincariol (UWO)	30	Page 34 - Highlight	Text updated to clarify.
Rob Schincariol (UWO)	31	Page 38 - 'neighbouring settings' is too vague. Be specific - cite locations / reports.	Text updated to note the neighbouring areas are Guelph, Region of waterloo and Town of Orangeville.
Rob Schincariol (UWO)	32	Page 38 - Note - Figures C2 and C3 have the same figure caption.	The title for Figure C3 was incorrect as noted and was updated.
Rob Schincariol (UWO)	33	Page 39 - There is quite a difference in the modelled vs. measured 460 m and 440 m head values near the Grand River (i.e. where the field values close to form a V and the model values parallel the river). This is probably due to your imposed boundary conditions and should not affect model performance; however, it would be good to discuss it in the report for clarity.	Text updated as suggested to explain the discrepancy.

Provincial Peer Review Comments: Centre Wellington Tier Three Water Budget, Risk Assessment Report

Peer Reviewer	Reviewer Comment #	Report Location	Reviewer Comment	Response
Hugh Whiteley (UG)	HW_01	General Comment	The scenarios chosen for evaluating risk are specified in the Technical Rules. I have one concern about the scenarios chosen. There is no mention of Climate Change in the description of any of the scenarios. I do not know if the Technical Rules require an evaluation of risks specifically associated with Climate Change. The report should state what consideration of climate-change effects is required and show that any required consideration of climate change is included.	The Technical Rules do not require an evaluation of risk associated with climate change associated with the Risk Assessment scenarios. The Risk Assessment scenarios consider average climate conditions as well as time-varying climate conditions including 2 drought periods during a 45-year climate record (1961 to 2005). Text was added to Section 4.2 to clarify that "The projected effects related to climate change are not evaluated as part of this Tier Three Assessment; however, these effects will be evaluated and documented in a subsequent report, similar to the climate change study completed in support of the Guelph-Guelph Eramosa Water Quantity Policy Study (Matrix 2018a)."
Hugh Whiteley (UG)	HW_02	Executive Summary and Section 8.3	Recommendation : Reduce uncertainty in risk assessment by collection of additional field data The results of the model calibration and Risk Assessment process suggest that there remains uncertainty relating to the conceptual model along the western model boundary, western lower aquifer, and karst features, particularly in the areas contributing to the Middlebrook Well. This results in relatively-high uncertainty attached to the Risk Assessment results which suggest that the groundwater source can supply the Allocated rates under average and drought conditions. ~~However,~~ There is an opportunity to reduce this uncertainty by filling the existing ~~this~~ important knowledge gap through collecting ~~should~~ high-quality geological data and conducting aquifer pumping tests ~~be completed~~ in the area.	As stated in Section 7.4.3, the uncertainty in the model parameters and exterior boundary conditions was evaluated in Section 3.2. Of the uncertainties tested, the change that could have the most significant impact on the Risk Assessment was identified to be a lower recharge rate. However, further evaluation of this scenario indicated that a recharge reduction of 20% would not lead to a change in the Risk Level. This lead to a "Low" uncertainty rating with respect to the Risk Level designation based on the assessment of model parameters and boundary conditions. Therefore, we do not believe that the uncertainty stated in Recommendation 1 would result in high uncertainty to the Risk Assessment results. However, there is higher uncertainty in the western area relative to areas closer to the Centre Wellington municipal wells where more higher quality data was available to support the conceptual model. Recommendation 1 has been refined: "1. Reduce uncertainty through collection of additional field data: The results of the model calibration and Risk Assessment process suggest that there remains uncertainty relating to the conceptual model along the western model boundary, western lower aquifer, and the localized influence of karst features. This results in less certainty in the model conceptualization and predictions in areas farther from the Centre Wellington municipal wells. There is an opportunity to increase certainty by filling the existing important knowledge gaps with high quality geological data and completion of aquifer pumping tests. The model's simulation of drawdown at the Middlebrook Well due to pumping from that well is also uncertain. There is an opportunity to reduce this uncertainty by similarly collecting additional local high-quality data and completing an aquifer pumping test in the area."
Hugh Whiteley (UG)	HW_03	Executive Summary and Section 8.3	Recommendation: Use of a refined Tier Three Model in assessing water-taking applications If new non-municipal water takings are proposed within ~~the vicinity of~~ the Groundwater Vulnerable Area, the Tier Three model, refined to take account of recent and anticipated new data on strata properties should be utilized, together with additional field data collected as part of the application, to determine the impact of the proposed water taking on municipal water supply reliability.	Recommendation 3 has been refined: "3.Use of the Tier Three model in assessing water-taking applications: If new permitted water takings are proposed within the Groundwater Vulnerable Area, the Tier Three model may be applied to determine the impact of the proposed water taking on municipal water supply reliability. In the event of such an application of the model, refinements may be needed in the area of that taking to account for new geological data, and should utilize additional field data collected as part of the application. If the Tier Three model is selected for utilization in a water-taking application, the necessity of these refinements may be assessed, at the time of a proposed taking, in conjunction with Centre Wellington, the GRCA, the Ministry of Environment, Conservation and Parks (MECP) and applicant. "

Hugh Whiteley (UG)	HW_04	Executive Summary and Section 8.3	Recommendation: Continue monitoring of well performance in a well-maintenance programme The Risk Assessment scenarios analyzed groundwater level decline assuming maintained well performance. The ability of the wells to sustain future pumping rates is dependent on ongoing monitoring of water levels within the municipal wells, as well as regular well maintenance. It is recommended that Centre Wellington continue to monitor water levels in the wells, well performance, and to rehabilitate the wells when needed to ensure the validity of the Risk Assessment results.	Recommendation 4 has been updated as suggested.
Hugh Whiteley (UG)	HW_05	Executive Summary and Section 8.3	Recommendation: Improved Model Calibration using expanded baseflow locations Model calibration to baseflow was limited by a single surface water gauge on Irvine Creek. Data from additional flow gauging stations should be obtained and used to better characterize the streamflow in other parts of the Study Area and the interaction between the streams and the groundwater flow system.	Recommendation 6 has been updated as suggested.
Hugh Whiteley (UG)	HW_06	Executive Summary and Section 8.3	Recommendation: Regular Upgrades of water-budgets by the GRCA. The Grand River Conservation Authority (GRCA) maintains water budget modelling tools to help manage and protect the water resources across the watershed. These modelling tools should be updated periodically as new information is gathered and insights evolve within the watersheds.	Recommendation 7 has been updated to "Regular updates of water budgets by the Grand River Conservation Authority (GRCA)"
Hugh Whiteley (UG)	HW_07	Section 2.2	The statement that "***The results of this uncertainty assessment suggested that groundwater recharge was the most uncertain model parameter"*** needs correction as it is not correct in two ways. First recharge to groundwater is not a model parameter it is an input to the model. Just as precipitation, together with air temperature, wind speed and water-vapour content of the air are the required input for streamflow-generation models recharge to groundwater is the required input for groundwater flow models. Secondly the groundwater recharge inputs used in the groundwater model are taken directly from the calibrated GAWSER model for the Grand River watershed. The values for groundwater recharge have been calibrated against long-term average baseflow values measured at a large number of streamflow locations within the Grand River watershed as part of the Tier Two modelling. The precipitation inputs on which GAWSER model results are based and the measurements of stream baseflow against which groundwater recharge is calibrated are the most accurate data sets used in the modelling process. Because the groundwater recharge values used in this modelling study have been demonstrated to be adequately accurate in the accepted Tier two modelling recharge should not be treated as appreciably uncertain. And recharge is not a model parameter.	Text was updated throughout the report to clarify that recharge is a boundary condition and not a model parameter. This language is now also consistent with how recharge is defined in the groundwater model report (Appendix B). The text was also updated in Section 3.2.1.3 to "Although the parameter uncertainty analysis suggests that groundwater recharge rates could be lower and achieve an acceptable measure of calibration, the source of the groundwater recharge estimates is the GRCA's GAWSER model. The GAWSER model has been well-calibrated to watershed hydrology conditions and its groundwater recharge estimates should remain the most reliable long-term estimates across the watershed. " Text in the executive summary has also been updated to the following: "The uncertainty assessment suggested that a scenario where existing groundwater recharge was lower than currently simulated had the greatest potential to further increase drawdown at municipal wells in the Risk Assessment scenarios and impact the Water Quantity Risk Level. While this assessment highlights groundwater recharge as a sensitive parameter, the estimates are derived from a calibrated watershed hydrology model that is believed to have a relatively lower range of uncertainty." Similar text was added in Section 9.1.
Hugh Whiteley (UG)	HW_08	Section 2.2	In the peer review discussion meeting of May 23 the recharge for Tavistock till of 50 mm/y was the main was referenced as being an example of the uncertainty of recharge. While it is true that because of the low value of recharge for this soil type even a small absolute change in recharge represents an appreciable percentage change I do not agree that the value of 50 mm/y has any appreciable uncertainty. I attach at the end of this comment a waterbalance calculation I have performed for the 30 year Climate Normal Period 1981-2010 for the Conestogo watershed above Drayton. This watershed has predominantly Tavistock Till or similar fine textured soil. The source of baseflow in this watershed is entirely groundwater discharge so the annual baseflow amount estimated at around 70 mm/y corresponds to the annual recharge to groundwater.	Thank you for the additional analysis to confirm the recharge applied in the numerical model.

			The baseflow separation method applied is intended to include all water reaching the watertable and thus includes water that reaches the stream through shallow short flowpaths just below the watertable, such as outflow from systematic buried-pipe field drainage systems. This very shallow-flowpath groundwater is treated as interflow in the modelling in the Assessment study and "recharge" for the Assessment groundwater model is the amount of water reaching the deeper groundwater system.	
			Taking account of the proportion of the 72 mm/y estimated total recharge that would be accounted for by interflow pathways the estimate for deeper groundwater recharge for the Conestogo watershed is very similar to the 50 mm/y used in the Assessment study as recharge for Tavistock till soils. A similar check could be made for watersheds predominately covered by other soil types and I am confident the annual recharge amounts for other soils would be similarly confirmed.	
Hugh Whiteley (UG)	HW_09	Section 2.2	I do not think it is appropriate to have groundwater recharge as a calibration parameter to be established using PEST as the calibration estimation tool. Furthermore the Objective function used was entirely based on waterlevel matching. Since there was only one location with a check on representation of baseflow the extent of matching of observed baseflow was absent from the measurement of calibration success. I think that the results of calibration runs which produced changes in recharge of more than 10% should be disregarded in terms of drawing conclusions about the accuracy of representations of the properties of the flow system. I would be very surprised if any of the runs with larger changes in recharge did not worsen the match between observed and modelled baseflow at the one check location on Irvine Creek.	We acknowledge that the 20% range of uncertainty expressed in the original version of the report is greater than what should be reasonably estimated for the GAWSER watershed model. However, the estimated GAWSER recharge may be significant particularly in low permeability soils. The following text has been added to the uncertainty section conclusions (Section 3.2.1.3): "Although the parameter uncertainty analysis suggests that groundwater recharge rates could be lower and achieve an acceptable measure of calibration, the source of the groundwater recharge estimates is the GRCA's GAWSER model. The GAWSER model has been well-calibrated to watershed hydrology conditions and its groundwater recharge estimates should remain the most reliable long-term estimates across the watershed."
Hugh Whiteley (UG)	HW_10	Table 1, Section 2.2.1.1	There was considerable discussion at the May 23 peer-review meeting concerning the uncertainty surrounding the amount of vertical flow through the aquitard overlying the deeper productive aquifers. The pertinent sections of the report include the summary of results of the uncertainty scenarios in Table 1 and the Water Budget Schematic in FIgure 10. Since the parameter of interest in this discussion is the vertical hydraulic conductivity the headings in Table 1 should reflect this.	A similar comment regarding vertical hydraulic conductivity and Table 1 was provided by another reviewer. Please see response provided for Comment "DR_02".
Hugh Whiteley (UG)	HW_11	Figure 10, Section 6.3	Separating out the water balance for the lower bedrock aquifers as produced by the modelling and shown in Figure 10 the net inflow is 11000 of which 3600 is lateral inflow and 7400 net leakage through the aquitard. The outflow is also 11,000 of which 5100 is pumping wells and 5900 lateral outflow. The net leakage into the lower aquifer is the larger component of inflow to the lower aquifer system and this should be emphasized in the Report. The discussion of uncertainty in this result and the reasons that led the study team to establish the vertical conductivity values for the aquitard that were used in the modelling needs to be expanded.	Figure 10 has been revised. Text has been added to Section 7.3 to highlight a water balance of the lower bedrock units, the uncertainty and how vertical leakage into the deeper bedrock units is predicted to change for the Risk Assessment scenarios (Table 13): "The water balance for the lower bedrock units (Goat Island and Gasport formations, Figure 10) indicates that lateral inflows account for 3,600 m3/day and net inflow due to leakage from overlying units accounts for 8,200 m3/day. This result suggests that a greater proportion of water in the lower bedrock units is sourced vertically from overlying geological layers, rather than laterally from the regional flow system. The uncertainty assessment described in Section 3.2.2 estimates the range of uncertainty of lateral flows along model perimeter boundaries. The water balance results suggest that an increase in municipal pumping in Scenarios G(1) and G(2)/G(4) is balanced by a small increase in lateral inflow in the lower bedrock, but mostly through increased vertical leakage (Table 13).

				The magnitude of vertical leakage is linked to the hydraulic conductivity of the upper Guelph Formation, which was parameterized in the Tier Three model through calibration process. The simulated horizontal hydraulic conductivity needed to be low enough to account for the 11 to 20 m observed vertical head differences across that unit (Appendix B). The lower range of calibrated horizontal conductivity values applied for the upper Guelph Formation is slightly lower than the field-derived range of values. This is because many of the hydraulic tests conducted within and outside the Study Area were targeting new water supply sources, and aimed to complete the wells in zones of enhanced transmissivity. The available field-derived values were therefore expected to be on the high side. Vertical hydraulic conductivity of the bedrock was set to be 10% of the horizontal hydraulic conductivity across the model domain. Uncertainty in the hydraulic conductivity values is greater outside the Fergus and Elora area. Vertical hydraulic conductivity in the Guelph Formation and leakage into the deeper bedrock units will vary depending on the presence of local unmapped heterogeneities such as weathered surfaces, fractures, buried valleys, and karst features."
Hugh Whiteley (UG)	HW_12	Section 2.2.1.1	In the uncertainty analysis for aquitard hydraulic conductivity it is noted, correctly, that increasing the hydraulic conductivity "resulted in the model estimating a reduction of 37% in groundwater recharge; this reduction is inconsistent with water budget estimates and therefore unlikely." Based on my earlier comments on the accuracy of groundwater recharge I suggest that this statement should be that higher hydraulic conductivities are not possible as they require reductions in the established recharge rates to achieve calibration. On the other hand the uncertainty test with lower hydraulic conductivity required no adjustment to recharge and the conclusion that lower hydraulic conductivity was feasible is correct. Given the large role of leakage to the lower aquifer system in the water balance of the system there should be some discussion of whether or not the conclusions of the report on the sustainability of the Fergus Elora water sources would be affected by reduced net leakage to the lower aquifer system. The successful modelling of the transient response from the extended Fergus/Elora pump test and the Middlebrook well pump test supports the conclusion that the vertical hydraulic conductivity for the aquitard used in the modelling adequately represented the flow system influenced by pumping of these wells.	We agree with the note and have added the text to the discussion in Section 3.2.1.1: "This recharge reduction is outside the range of uncertainty and it is therefore very unlikely that the hydraulic conductivity of the Upper Guelph Formation would increase to the amount considered in the scenario."
Hugh Whiteley (UG)	HW_13	Page vi	The Groundwater Vulnerable Area is ~~a circular~~ roughly rectangular area that encompasses the Centre Wellington municipal wells and extends toward the west.	The text was revised to "The Groundwater Vulnerable Area encompasses the Centre Wellington municipal wells and many of the non-municipal takings simulated in the Study Area."
Hugh Whiteley (UG)	HW_14	Page 27, Section 4.2.3	**4.2.3 Other Water Uses** Other water uses that are relevant to the Study Area for this current assessment include aquatic habitat uses (e.g., coldwater streams) and Provincially Significant Wetland uses (Figure 6). In addition flows in the Grand River below Shand Dam provide wastewater-assimilation capacity. During periods of normally-low baseflow In summer and autumn baseflow in the Grand River downstream of the Shand Dam is maintained by releasing water from Lake Belwood. The contributions to the Grand River from the Study Area as groundwater discharge were found to be a minor component (approximately 10%) of the flow maintained from the Lake Belwood and therefore any impacts of reduced groundwater discharge to baseflow ~~reductions~~ would have an insignificant impact on wastewater assimilation in the Grand River and have not been assessed.	The text was revised as indicated with minor revisions in Section 5.2.3.

Hugh Whiteley (UG)	HW_15	Figure 8	Figure 8 Should have title "***Location of stream segments evaluated for baseflow reductions***"	The figure title has been update as indicated.
Rob Schincariol (UWO)	RS_01	Exec. Summary. Pg vi. Last paragraph under "Water Budget Tools"	The Middlebrook well is not shown in any of the figures contained within this report. As it is discussed in the report, its location should be either added to one of the figures in the report OR a reference given to where it can be found in the Physical Characterization report (Figure 21).	Text has been added to Section 5.2.2.1 to address this: "The location of the Middlebrook Well is found in Figure 21 of Appendix A."
Rob Schincariol (UWO)	RS_02	Section 2.2.1, second last sentence of second paragraph	From the May 23rd Peer Review Meeting it was clear Frank Brunton did not agree with the regional 'aquitard' and 'aquifer' statements. The concept of aquifer versus aquitard is comparative and relative. Furthermore, the term 'regional' versus 'local' is also relative to the studied scale. Thus when you refer to the Upper Guelph as being a regional aquitard, versus the Goat Island and Gasport being regional aquifers, it is a model scale characterization of these units with the 'aquifer' having an overall higher permeability than the 'aquitard', and the aquifer being used for water supply. That said looking at hydraulic conductivity (K) values for these units (Table 6 from the Calibration report), and various cross sections from the Characterization report, it is difficult to understand your statement on regional aquifer / aquitard. The Guelph formation has K values comparable to the Goat Island / Gasport and numerous wells in the cross sections have their screened intervals in the upper portions of the Guelph. If you are referring to a specific model layer in the Guelph (i.e. that to which you assigned a very low K) then this should be identified with supporting information / reference to the Characterization or Calibration reports. In addition it may be that your assignment of model layer properties is at odds with local field derived values at some locations. This may be a result of having to approach the study using an equivalent porous media approximation. A discussion of this would help in the uncertainty assessment.	The uncertainty assessment Section 3.2 and Figure 10 have been refined to remove 'regional aquifer' and 'aquitard' references and focus on the bedrock formation names instead. Discussion of the Upper Guelph Formation and how a relatively low simulated hydraulic conductivity was required for that unit to account for the 11 to 20 m observed vertical head difference was discussed in Appendix B. Part of that discussion has now been brought forward to Section 7.3 in response to peer review comment HW_11.
Rob Schincariol (UWO)	RS_03	Table 5	Why start at 1961 here and 1960 for transient simulations?	The table has been updated to show 1961 to 2005 for both average and transient time periods.
Rob Schincariol (UWO)	RS_04	Section 4.2.2.2	From the May 23rd Peer Review Meeting I understand the Middlebrook well was not included / represented in the model as it no longer has a valid permit and is not pumping. However, this was not made clear within the Assessment Report. Given the Middlebrook well has been mentioned in this report, and identified in the Physical Characterization report, I would recommend explicitly stating it was not included, and why.	Text has been added to Section 5.2.2.1 to address this: "Simulated pumping from the Middlebrook Well is not included in the calibrated base case model (Appendix B), nor is it included in the Risk Assessment scenarios (Section 4.2). The Middlebrook Well is not currently pumping because it does not have a Permit To Take Water (PTTW). Only known municipal and non-municipal groundwater takings are considered for inclusion in the groundwater flow model."
Rob Schincariol (UWO)	RS_05	Figure 10	Figure 10 is problematic. Your flow lines as depicted do not represent flow in aquifers versus aquitards. You would not have a flowline start at surface and form a nice curve upwards through the Upper Bedrock Aquitard and then back again into the Upper Bedrock Aquifer. Perhaps this is actually happening at the field scale with high K horizontal features in the Upper Bedrock Aquitard. But as presented the figure raises more issues than it addresses. If you want to convey the flows, one could replace the thin dotted continous flow lines with simple vertical arrows (as you have done with identifying the lateral flows). Thus simply present the vertical and horizontal flow components, not detailed flow paths.	Figure 10 has been updated with simple block arrows as suggested.

Rob Schincariol (UWO)	RS_06	Appendix C, first paragraph, last sentence	Given these monitoring wells were constructed for the City of Guelph and one is a PGMN well, no explanation is given why only one year of data (2010-11) or two years of data (2009-11) are used for this review. In the context of this report I would not consider these 'long-term hydrographs' as noted. Longer term records are likely available for these wells; why not use them?	To our knowledge, recent and/or long-term water level data from monitoring wells installed as part of the Guelph-Guelph/Eramosa Township (GGET) Tier Three Assessment are not publicly available. The water level data examined was reproduced from the GGET Tier Three Assessment report that is publicly available. Long-term water level data from the PGMN well was available from 2001 to 2014; however, that water level variation may be influenced by municipal pumping from the Grand Valley municipal wells. Other bedrock monitoring wells that show continuous natural water level variability were lacking in and adjacent to the study area. The text of Appendix C was revised to say that "....water level fluctuations were estimated through review of *available* hydrographs from monitoring wells completed within bedrock." Further detail was added to Appendix C : "Based on these hydrographs, a representative natural water fluctuation of 2.0 m was selected for use in the delineation of the WHPA Q1 area for Centre Wellington. *This drawdown threshold is consistent with the 2.0 m threshold used in the GGET Tier Three Assessment (Matrix 2017) for the municipal wells completed within the bedrock groundwater system of the neighbouring municipality and has been accepted by the Province."*
Rob Schincariol (UWO)	RS_7	Appendix C, Paragraph 3, Figure C1	Assume you mean 'Chart C1' as labeled. While it is your call I am not sure why all of a sudden the report starts to use the term 'Chart' instead of 'Figure'? Seems odd as the Chart is no different than other Figures in the report.	The reference to Figure C1 is meant to direct the reader to a map that shows the location of the PGMN well. The text has been revised to: "….which is located approximately 21 km northeast from the Town of Fergus and 3 km north of the model boundary (s*ee Figure C1 for well location*). Charts C1 through C5 have now been pulled out of the text and are now included as separate Figures C2 through C6. The text reference to the charts have also been updated.
Rob Schincariol (UWO)	RS_8	Peer Review Meeting Comment	Peer review meeting: R. Schincariol suggested that Matrix should add a disclaimer to the report on how and at what scale the model should be used.	A section describing what and where the model may be used to evaluate is provided as Section 9 of the Groundwater Flow Model Development and Calibration Report (Appendix B) and that section has been brought forward to the main Risk Assessment report (Section 3.4).
Rob Schincariol (UWO)	RS_9	General Comment	The Peer Review Record shows a gap in the responses to my comments. Comments RS 03, 04, and 05 are missing / not addressed. The issue is that my comment 05 was addressed by the removal of the previous section 2.2.3 ‘Karst Assessment’ and thus comments 03 and 04 were also then addressed.	Correct, in response to the consensus of the review team, the Karst Assessment Section (Previously Section 2.2.3) has been removed from the Risk Assessment Report and documented under a separate memo. Comments related to that section have been removed here and are included as an attachment to that memo. The present remaining comments were re-numbered.
Rob Schincariol (UWO)	RS_10	Section 3.2, Model Uncertainty Assessment	Matrix has added the statement “Models are merely numerical presentation of actual conditions, …”. I would recommend that ‘actual’ be replaced with ‘simulated’ or ‘presentation’ be replaced with ‘approximations’. I doubt Matrix intended to state the model represents the ‘actual’ (synonym ‘real’) conditions as the remaining part of the sentence discusses the uncertainty.	The word "presentation" was replaced with "approximations".

Dave Rudolph (UW)	DR_01	Pg 10, Section 2.2.1.3 Recharge Uncertainty Assessment	As noted at several points within the text, the uncertainty related to the groundwater recharge magnitude and distribution is relatively high. As was discussed several times in the meetings (and in different related reports), the recharge boundary condition is derived from a previously calibrated GAWSER model. In the final text for the water balance, it is likely of value to remind the reader how that upper model boundary was derived and at what special density. The decision was made to assess the sensitivity of the recharge by increasing and decreasing it everywhere by 20%. Does this provide enough confidence in the adopted recharge values that are used in the scenario assessment? Perhaps a more extensive explanation of the influence of uncertainty associated with the recharge boundary condition would be of value in understanding the level of certainty one can have in the overall water balance and scenario results. Groundwater recharge is such a significant component in the overall balance.	A summary of how the recharge model boundary condition was derived is now provided in Section 3.1 (Model Summary). This text has been expanded to elaborate on the recharge and how it is assigned spatially. The implications of a scenario where recharge may be decreased by 20% (resulting in a calibration that is statistically better than the base case calibrated model) was tested and detailed later in the report (Section 7.4.3.3). Since a model scenario with 20% less recharge could have an effect on the Water Quantity Risk Level, Risk Assessment Scenario G1 (representing future land use and future municipal pumping) was re-evaluated using 20% lower recharge. The results indicated that a reduction in recharge of this magnitude would not lead to simulated groundwater levels at municipal wells declining below their safe thresholds (i.e., setpoints) and not lead to a change in the Risk Level. A sentence has been added to Section 3.2.1.3, directing the reader to Section 7.4.3.3 so that they are not left wondering of the possible implications of an improved calibration with a model that has 20% less recharge. The following text has been added to address question of water balance in Section 3.2.1.3: " Although the parameter uncertainty analysis suggests that groundwater recharge rates could be lower and achieve an acceptable measure of calibration, the source of the groundwater recharge estimates is the GRCA's GAWSER model. The GAWSER model has been well-calibrated to watershed hydrology conditions and its groundwater recharge estimates should remain the most reliable long-term estimates as part of the complete water balance across the watershed. "
Dave Rudolph (UW)	DR_02	Table 1, Horizontal vs. vertical hydraulic conductivity	P. 11 and Table 1. The left hand column lists "Horizontal Hydraulic Conductivity" whereas the other columns list Kxy. This could cause some confusion. Also, how is the vertical K in the aquitards assessed in the sensitivity analysis as this is potentially an important parameter. Are the units considered isotropic or anisotropic?	The column headings in Table 1 have been updated to improve clarity. The "Horizontal Hydraulic Conductivity" heading was revised to "Horizontal Hydraulic Conductivity (Kxy)". The base case modelled units are considered anisotropic; however, content was added to Table 1 to expand on how the anisotropy ratio (Kxy/Kz) was fixed or varied for each scenario. Text was added to Section 3.2.1 to expand on this point: "Each model uncertainty scenario was completed by first making a specific adjustment to recharge or the horizontal and vertical hydraulic conductivity of a hydrogeologic unit. Depending on the scenario, the anisotropy ratio between the horizontal and vertical hydraulic conductivities was fixed or allowed to vary from the base case calibrated model. During the base case calibration, the vertical hydraulic conductivity was set to be 10% of the horizontal hydraulic conductivity for all layers, except for one small overburden area where a higher anisotropy value was applied to account for interpreted interbeds of coarse- and fine-grained material. "
Dave Rudolph (UW)	DR_03	Section 2.2.2 Model Boundary Uncertainty Assessment	The lateral boundary conditions on the model are a challenge to specify and the text explains the rational for their selection and some idea of the sensitivity related to changing the specified constant head boundaries. Overall, how sensitive or critical are these boundary values to the water balance and scenario evaluations. I suspect they are not too influential but it would be of use to expand on this point to some degree. Are the designated heads along any given reach a uniform value with depth or do they vary depending on the unit such that there may be some vertical gradients?	The assigned boundary condition values vary over depth depending on the unit and the hydraulic head data available in these units, which results in vertical gradients along some boundary reaches. Details of assigning boundary conditions are in the Calibration Report (Appendix B of the Risk Assessment Report). This text has been added to Section 3.2.2.
Dave Rudolph (UW)	DR_04	General Comment	The overall model is "validated" through detailed comparison to the data in the vicinity of Elora and Fergus, due to the availability of dense and transient data. This is logical. How does the goodness of fit and validation results in this small (~15% of the model domain) region relate to the model performance outside of this area and can we make the statement that it does not matter very much as long as things fit reasonably around the production wells?	We have added text in Section 3.2.3 that provides some guidance on how to address higher level of calibration certainty in the areas of the municipality versus areas outside.

Dave Rudolph (UW)	DR_05	General Comment	In the recent meeting there was a discussion of the location of potential future groundwater supply wells as recommended by AECOM I believe. It may be of value to explain in a bit of detail where these might be located in the future and any potential implications of those specified potential new sites. It would be useful to know how they were selected.	Options to increase future water supply will be discussed as part of the Water Supply Master Plan that is in progress for the Township of Centre Wellington. It has been recommended in this report (Executive Summary and Section 9.3) that the Risk Assessment scenarios be repeated in the future as new data becomes available through the results of the Water Supply Master Plan to assess new sources regarding their sustainability in meeting future municipal demands.
Dave Rudolph (UW)	DR_06	General Comment	As the flow within the Grand River is always a point of contention, can the impact of pumping from the various scenarios on baseflow in the Elora and Fergus stretches of the Grand be provided? They are likely to be very low, but it would be useful to state that.	The following text added to section 7.2.2. "The greatest absolute simulated groundwater discharge reduction between Scenarios C and G(4) is 1,700 m3/day. This result is from an analysis of a stretch of the Grand River, which extends from just east of Fergus, to the model domain boundary south of Elora. This reduction is approximately 5% of the total estimated groundwater discharge, and less than 1% of the typical minimum flow of the Grand River through this reach. All recharge reductions are less than the 10% threshold specified through the Technical Rules; therefore, a Low Risk Level would be assigned based on impacts to coldwater streams."

November 3, 2019

Sonja Strynatka M.Sc., P. Geo.
Senior Hydrogeologist, Grand River Conservation Authority
400 Clyde Road, Cambridge ON, N1R 5W6

Re: Acceptance of Centre Wellington Tier Three Water Budget Draft Risk Assessment Report

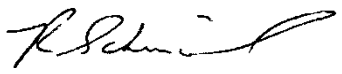
Dear Sonja,

I have reviewed the Centre Wellington Tier Three Water Budget Draft Risk Assessment Report and the associated peer review matrix (*Version 0.3; October 2019)*. I conclude that the work is scientifically defensible, that the deliverables are consistent with the expectations of the province's source water protection framework. However, I do have a few additional minor concerns on how my comments were addressed in the Peer Review Record, and edits arising from the review in general.

1. The Peer Review Record shows a gap in the responses to my comments. Comments RS 03, 04, and 05 are missing / not addressed. The issue is that my comment 05 was addressed by the removal of the previous section 2.2.3 'Karst Assessment' and thus comments 03 and 04 were also then addressed.

2. Page 26 of pdf, Section 3.2, Matrix has added the statement "Models are merely numerical presentation of actual conditions, …". I would recommend that 'actual' be replaced with 'simulated' or 'presentation' be replaced with 'approximations'. I doubt Matrix intended to state the model represents the 'actual' (synonym 'real') conditions as the remaining part of the sentence discusses the uncertainty.

Sincerely,



Dr. Rob Schincariol, P.Geo.
Professor, Hydrogeology and Watershed Hydrology
Department of Earth Sciences
University of Western Ontario
London, ON, N6A 5B7

APPENDIX E

PROVINCIAL PEER REVIEW COMMENT RECORD

Note: the preceding letter from Dr. Rob Schincariol (dated November 3, 2019) provides two additional comments regarding the Risk Assessment Report. These comments have been addressed as part of the *Centre Wellington Tier Three Water Budget, Risk Assessment Report, Provincial Peer Review Comment Matrix* (comments RS_9 and RS_10) found here.

Sonja Strynatka M.Sc. P. Geo.
Senior Hydrogeologist
Grand River Conservation Authority
400 Clyde Road I Cambridge ON
N1R 5W6

November 1 2019

RE: CENTRE WELLINGTON TIER THREE WATER BUDGET DRAFT RISK ASSESSMENT REPORT

Sonjq:

I have now reviewed the responses to peer review comments on the Centre Wellington Tier Three Water Budget Draft Risk Assessment Report.

I am satisfied that the changes made to the report have incorporated all of the comments that required revisions. I comment the authors for their careful consideration of the comments.

I recommend that the report be approved and distributed as revised.

Yours truly

H R Whiteley

H.R. Whiteley P.Eng..
2422 115 Cherry Blossom Circle
Guelph ON N1G 0A3

From: David Rudolph <drudolph@uwaterloo.ca>
Sent: Tuesday, November 5, 2019 3:42 PM
To: Sonja Strynatka <sstrynatka@grandriver.ca>
Subject: Centre Wellington Tier 3 study

Dear Sonja,
I am satisfied with the final edits to the Centre Wellington Tier 3 study report related to my comments and do not require any further edits.

Thanks again for including me in this very interesting study and I hope the results prove valuable in the long term management of the water resources in this region.

Best regards,
Dave

David L. Rudolph, PhD, PEng
Professor and Chair
Department of Earth and Environmental Sciences
University of Waterloo
200 University Avenue
Waterloo, ON
N2L 3G1
Ph. 519-888-4567 (ext. 36778)
drudolph@uwaterloo.ca

UNIVERSITY OF WATERLOO
FACULTY OF SCIENCE

APPENDIX F
Local Knowledge Peer Review Comment Record

Local Knowledge Peer Review Comments: Centre Wellington Tier Three Water Budget, Physical Characterization Report

Peer Reviewer	Reviewer Comment #	Reviewer Comment	Response
Abdul Quyum (MOECC)	1	Section 1.1: it is indicated that the Scoped Tier Three Assessment report will be used to identify potential change in water level in the municipal wells due to climatic variability. I am not clear how this study (groundwater model) will able to predict climatic change induced impact on municipal aquifer water levels without assessing or knowing the municipal aquifer recharge source and its location unless it is assumed that the municipal aquifer is locally recharged and hydraulically connected with the overlying overburden or bedrock unit. The information provided in section 2.5.2.1 of the report suggests that the municipal bedrock aquifer is confined because of the presence of Maryhill Till, the Catfish Creek Till and the Lower Catfish Creek Till over the bedrock. An explanation is needed.	The groundwater flow model will be calibrated to current (existing) groundwater recharge and pumping conditions within the study area. We will then modify the groundwater recharge term in the model to simulate wet and dry periods present through drought years such as the 1960s and late 1990s drought. These scenarios will use past droughts as a proxy for future potential droughts. The model will simulate wet and dry seasons (i.e., climate variability) not climate change. In other words, this portion of the project uses the climate observed in the past as a proxy for the future.
Abdul Quyum (MOECC)	2	Section 2.4.3, Regional Quaternary Geology: Has lateral and vertical extent of the overburden unit outlined in this section been confirmed within the Study Area?	The lateral and vertical extent of the overburden units are based on interpretations of high quality overburden cores collected across the study area and lithologic information within water well records. These are the only hard data available to 'confirm' the lateral and vertical extent of overburden units.
Abdul Quyum (MOECC)	3	Section 2.5, Table 6: In this table, various hydrostratigraphic units have been characterized as aquifers or aquitards. Have they been characterized based on actual hydraulic conductivity data or based on sequence stratigraphy? Can it be confirmed, based on the existing geologic and hydrogeologic data reviewed and summarized in this report, that available information are adequate in providing adequate spatial coverage in determining the lateral and vertical extent of the these hydrostratigraphic units within the Study Area?	The hydrostratigraphic unit type is based on our understanding of the primary materials present within each given unit, and are not based on actual hydraulic conductivity tests. The groundwater flow model is regional in scale, and refined locally around the municipal wells where higher quality data exists. This type of regional scale water budget modelling is different than a groundwater flow model developed to answer questions on a site specific basis (i.e., contaminated site).
Abdul Quyum (MOECC)	4	Section 2.5.1.1, Bedrock Conceptual Model Layer Development: The conceptual bedrock model is based on very limited actual drilling data which too is concentrated closer to the Elora and Fergus municipal well fields. Considering the size of the model domain which extends about 20 km to the north, east and west and 10 km to the south from F7 (municipal well), there appears to be a disconnect between the conceptual geologic and hydrostratigraphic model domain and actual data available on local geology and hydrogeology within the Study Area. According to Figure 5, 18 municipal and monitoring wells are available within the Study Area. It appears that the Scoped Tier Three assessment is over-relying on modelling approach without adequate local scale input on the geology and hydrogeology. This would have implications (uncertainty) for the size of the modelled municipal wells capture zones and predictive impact assessment of drought and induced climate change on the municipal water supply.	Water budget studies that evaluate the cumulative impacts of municipal takings in the short and long term need to have large areas. We acknowledge that there is a lack of high quality data north of the Study Area and outside the Fergus and Elora area; however, it is our professional belief that the model needs to extend this far to capture the source of water to the municipal wells. The model domain is fairly consistent with previous models developed in the area, and for other Tier Three Assessments conducted across Ontario.

Abdul Quyum (MOECC)	5	Section 2.5.3, Cross-Sectional Views of the Hydrostratigraphic Layers: Additional cross-sections (north-south through Fergus and Elora municipal well fields and east-west in the northern portion of the study area) should be added to confirm that the conceptualized geologic and hydrostratigraphic conditions are consistent across the Study Area. With respect to cross-sections A-A' (northwest-southeast), there is no monitoring well available which penetrated below the Guelph Formation to the west of E1, suggesting that there is no actual data point available to determine the actual thickness of the Guelph Formation, Goat Island Formation and Gasport Formation between E1 and northwestern cross-section boundary (about 18.5 km stretch). Similarly, there are only two data points (E1 and E4) for the Gasport Formation which terminated within the Gasport Formation in this 33.3 km long regional cross-section. The spatial variation of the bedrock thicknesses within the Study Area appears to be a scientific guess as actual information is lacking in confirming depth, and thickness of the various bedrock units and nature of secondary porosity (fractures and karstic structure) and its impact on the flow system. Similar observations can be made about geologic cross-section B-B' (southwest-northeast) which shows five monitoring wells drilled into the Cabot Head Formation in the Study Area. The Figure 11 does not include the Middlebrook Well (MOE#6707936) and it is not clear why this well has not been included in cross-section B-B'.	The cross-sections were drawn to illustrate the locations of the wells and the resultant bedrock layers; these cross-sections were not used to develop the model layers. As outlined in the text, the model picks were provided by Frank Brunton using all the available regional scale high quality data available in the Study Area and the surrounding areas (i.e., oil and gas wells not illustrated on the cross-sections). Additional cross-sections will be provided in the subsequent Model Development and Calibration Report.
Abdul Quyum (MOECC)	6	Section 3.1.3, Arthur and Marsville Municipal Wells: The municipal well locations should be shown on Figure 1 and be included in cross-sections.	The Arthur and Marsville municipal wells were added to Figure 1 for location reference, but were not added to the cross sections due to time constraints.
Abdul Quyum (MOECC)	8	General Comment: b) The report title is not consistent with the project work plan shared with technical stakeholders and information available on the Grand River Conservation Authority (GRCA) for Lake Erie Source Protection Region. This is a Scoped Tier Three Water Budget Assessment instead of a Tier Three Water Budget Assessment.	The report title has been updated to "Centre Wellington Scoped Tier Three Water Budget Assessment" to be consistent with the work plan.
Abdul Quyum (MOECC)	7a	General Comment: a) The report provides a summary of the existing geological and hydrogeological information. The report does not provide interpretations about a) nature of the municipal aquifer such as confined, leaky confined or unconfined, b) hydraulic connection between the municipal wells production zones and overlying overburden or bedrock units, c) source(s) of the municipal aquifer recharge and its location (is it locally or remotely recharged), and d) whether the existing geologic, hydrogeologic and geochemical data provides adequate spatial coverage for the entire Study Area.	Comment is acknowledged and several of these comments were added to the report, or will be addressed in subsequent Tier Three Assessment Reports.
Abdul Quyum (MOECC)	7b	The report does not identify data gaps or area within the Study Area where additional geologic and hydrogeologic information are required before proceeding to Task 3 (Numerical Modelling). If the existing geologic and hydrogeologic information are assumed to be adequate, then it should be explained why artesian conditions are observed at the Middlebrook Well compared to the non-artesian conditions at a nearby municipal well at E4. The municipal well E4 is located about 1.5 km to the east of the Middlebrook Well with a completion depth similar to the Middlebrook Well. This may suggest that the hydraulic characteristics of the municipal aquifer, at least in the Elora area, are not uniform. The consultant has indicated in section 4.4.3.2 of the report that "the source of the artesian conditions at the Middlebrook Well is not well understood". Despite the fact that the municipal aquifer behavior is not uniform in the Elora municipal well field and one of the objectives of the Scoped Tier Three Assessment is to better understand the municipal aquifer at a local scale, no additional investigations are recommended to investigate the observed artesian conditions at the Middlebrook Well. The groundwater flow model should be calibrated to the groundwater conditions observed at the Middlebrook Well	The data gaps for the project will be noted and summarized in the Model Development and Calibration report. The discussion of the data gaps and understanding of the artesian conditions at the Middlebrook Well will also be added at that time. We agree that the bedrock flow system in this area is complex and the groundwater flow model will be used to try to better understand the potential drivers for the artesian conditions in the area. The observed water levels in the Middlebrook Well will be used as high quality data during the model calibration, particularly the response at the Middlebrook Well when the Elora Wells were pumped and shutdown.
Frank Brunton (OGS)	1	Peer Review Meeting. 'Salina Formation' should be 'Salina Group'	Salina Formation' has been updated to "Salina Group" on Figure 5, 11, 12 and in the text.

Frank Brunton (OGS)	2	Peer Review Meeting. There is a new OGS document that will be coming out that discusses additional hydraulic conductivity testing in wells in the study area	This report is now available and estimates of hydraulic conductivity from the discrete hydraulic testing of wells in the study area have been included in the summary in Table 12 of the report. This data will be used in concert with all the other data sources to guide numerical model parameterization and calibration.
Ray Blackport (Blackport Hydrogeology Inc.)	1	General Comment: Overall, the physical characterization appears to be reasonable, based on the existing information. Deference is made to Frank Brinton for the geologic interpretation, and subsequent hydrostratigraphic interpretation. As noted in the report, there is a general characterization of geologic units into aquifers and aquitards, with the caveat that there is wide variation in hydraulic conductivity in some geologic units. Refining the hydraulic conductivity will be a key part of the model calibration and sensitivity analysis.	Comment acknowledged. The conductivity assigned in the numerical model will be guided by historical reported values derived from field-testing (summary provided in Table 12 of Characterization report), using literature values and will be refined through model calibration and sensitivity analysis. This will be documented in the model development and calibration report.
Ray Blackport (Blackport Hydrogeology Inc.)	2	Comments on the Meeting Summary Notes: Concerns regarding the Study Area boundary cutting across water courses in the eastern portion of the study area are not warranted. The focus of the modelling is the deep bedrock aquifer system and leakage to the deep system through bedrock aquitards. The regional groundwater flow is from northwest to the south, with the Grand River acting as a shallow discharge area, so there will be minimal impact to the overall assessment by modifying the boundary condition along the eastern boundary of the model. With respect to extending the model boundary to the City of Guelph, the current approach by Matrix appears to be reasonable, and the water level (constant head) boundary is being re-examined by Matrix. Having the model boundary as far north as is currently in the flow model is appropriate, given the likely extent of the capture zones for the Fergus and Elora well fields. With respect to the discussion regarding sudden changes in the bedrock contact elevations along cross-sections, appearing to show irregularities, it may be appropriate to review the stratigraphic interpretation in some areas, where the data are limited. For example, in Cross-section B-B' (Figure 11), why is the Goat Island (Ancaster Member) so much thicker across the entire western portion of the section and the Goat Island (Niagara Falls Member) so thin. Is this based on one data point? As well, does this change in thickness affect the flow system, or are the hydraulic conductivities similar so there may not be much of an impact to the flow model, and it is more of a "visual" issue.	The Goat Island thickness is based on interpretations made by Frank Brunton of the OGS using the wells outlined in the report and illustrated on Figure 5. It is likely that the difference in K between the two formations will be similar at the start of model calibration, and complexity in the hydraulic conductivity values will be added where supported by data. The vertical exaggeration of the cross-sections (e.g., 50x on B-B') may also visually exaggerate changes in bedrock contact elevations along the sections.
Ray Blackport (Blackport Hydrogeology Inc.)	3	Other Considerations (for the final characterization report): Any substantial deviation from previous characterization, with the greatest emphasis on the most recent characterization by Golder, should be discussed or a least summarized in a table, e.g. what was the change; what data, new or old were used to support the change; and, potential implications to the flow model.	New Section 2.7 has been added to the report as suggested to note the key differences between the Golder report and the current conceptualization.
Ray Blackport (Blackport Hydrogeology Inc.)	4	Other Considerations (for the final characterization report): A key component of the calibration will be matching the shallow intermediate and deep water levels with a good a fit as possible. The current figures, figures 15, 16 and 17, provide interpolated water levels, but are difficult to compare to overlying or underlying systems. Perhaps a presentation of vertical gradients would provide a better visual picture and easier interpretation of the hydraulic connection between the shallow, intermediate and deep systems. This may also provide insight in areas that are potentially hydraulically connected, and/or show where there may be important data gaps. This could also show where there could be issues and/or provide insight into water levels in long open boreholes/wells, and subsequent use of these water levels in model calibration.	Vertical head difference maps were added as requested to illustrate the differences in water level elevations between overburden and shallow bedrock and shallow and deep bedrock.

Ray Blackport (Blackport Hydrogeology Inc.)	5	Other Considerations (for the final characterization report): As a follow up to the previous bullet, understanding the water levels in long open holes/wells could aid in the model calibration. Recognizing there is limited budget for field work, it may be most cost effective to conduct packer testing, where possible in deeper boreholes/wells, to isolate zones and look at water level changes above and below the packer e.g. the Well Initiatives well in Salem. It may be worth looking at the distribution of deeper wells and determining if there are areas where it would be most beneficial to have this additional information, and determine if it is possible to test some of these wells.	Yes we agree that this would provide additional data on the K values at different elevations within the bedrock in an area outside the pumping and monitoring well network. This is outside the scope of our study but agree it would provide added value to the project.
Ray Blackport (Blackport Hydrogeology Inc.)	6	Other Considerations (for the final characterization report): There have been several discussions regarding capturing additional water taking information and/or larger scale water taking where there is limited data (e.g. Donkers). It may be useful to at least attempt to capture this information for the modelling exercise, using average water taking of private wells where there is a large area on private wells (e.g. Salem) or average usage for livestock, where there are large livestock operations. Even if there is only a small percentage of water taking, relative to the overall water taking in the Centre Wellington, it would provide a more complete assessment of the water taking.	Larger scale non-municipal, non-permitted water takings have been included in the assessment of water demands where that information was available (i.e., Donkers poultry was included). Matrix will work with Wellington Source Water staff to collect and include additional non-permitted water takers in our assessment.

Local Knowledge Peer Review Comments: Centre Wellington Tier Three Water Budget, Groundwater Flow Model Development and Calibration Report

Peer Reviewer	Reviewer Comment #	Reviewer Comment	Response
Abdul Quyum (MOECC)	1	Section 3.1.1, Simulating Bedrock Flow: High k- value appears to have been assigned to represent highly fractured bedrock (karst), most likely in the vicinity of the Middlebrook well, in which the presence of karst (production zone) has been confirmed. The question we have is about the lateral and vertical extent of these high k-value zones. Artesian conditions are known to exist at other locations. For example, a change in artesian flow to non- artesian was reported, alleged to be result of the 2004 pumping test, at a well located about 1.1 km south of the Middlebrook (section 3.2.2 of the GLL March 2005). Are the high k- zones adequately represented in the model?	Discussion added to the report in the data gaps section regarding the karst areas that supply the Middlebrook well and their distribution beyond the Middlebrook Well area.
Abdul Quyum (MOECC)	2	Section 3.8.1: Hydraulic Conductivity Values: It is our understanding that each model layer outlined in Table 2 was assigned a uniform hydraulic conductivity from a range of hydraulic conductivity values noted in Table 4. This section gives the impression that hydraulic conductivities within a single model layer, defined as a high conductive zone, was adjusted in order to achieve suitable model simulation with the measured head. Consistent with the comment noted above, the report should explain the process that was followed to identify the presence of such high conductive zones, and their lateral and vertical extent. The borehole logs, if used in the identification of high conductive zones, should be referenced so the readers can cross-check the accuracy of the information. If actual geologic and hydrogeologic information do not exist, then this is expected to be noted as one of many factors responsible for inducing uncertainty. Significant variability in location and size of the water producing fractured zone in the same bedrock formation is expected which could be a reason for the observed artesian flow at the Middlebrook well and non-artesian conditions at municipal well E4.	Multiple hydraulic conductivity zones were assigned in each model layer. See figures C1 to C5 in Appendix C that illustrate the distribution of hydraulic conductivity values. Borehole logs were not used to identify high hydraulic conductivity zones; the conductivity values were iteratively tested within the range of values during the model calibration until a match was achieved between the simulated and observed values in both the pumping test and long term average annual conditions.
Abdul Quyum (MOECC)	3	Section 4.3.2.2: Higher Quality Datasets- Other Date Sources: A multilevel well (**DDH5-09**) was installed by OGS at 7372 Middlebrook Road, Elora and since its installation, OGS conducted groundwater level and quality monitoring at this location. Given this well location is closer to the Middlebrook Well, this multilevel well should be used as a high quality data point for simulation of water elevation and calibration. In addition, the consultant should provide a commentary as to the availability of high quality data points in providing adequate spatial coverage for the model simulation and calibration especially to the north/northeast and south/southwest which are designated as a flow boundary, i.e. into and out of the model domain. According to Figures 8 and 9, north of Fergus, municipal and monitoring network, four high quality monitoring wells are available for steady state calibration and no high quality monitoring well is available for transient calibration.	We contacted Elizabeth Priebe at the OGS multiple times in the project, and the water level data for DDH-05 (which she is working on) is still unavailable. She thought the data would be available but she has not had time to process it yet. The data gaps section will describe the lack of high quality geologic and hydrogeologic water level data to the north/ northeast.

Abdul Quyum (MOECC)	4	Section 5.1: Quantitative Assessment of Model Performance: An error of ± 5 m, based on Root Mean Square Error and Mean Absolute Error, was indicated to be an acceptable calibration range whereas simulated vs observed water level for steady state calibration on Figure 11 was plotted for ± 10 m range. Considering public interest in the study area, the error between simulated vs. model water elevations should be explained from a viewpoint of effect on available drawdown, and impact or no impact on water supply even if water elevation is lowered by the estimated margin of error. In addition, the report should comment on the degree of calibration and accuracy of model predictions closer to the municipal wells versus elsewhere in the model domain area especially in areas where high quality input data and calibration targets are limited or non-existent.	Text was added to the report regarding confidence in the model in areas near Fergus and Elora and reduced confidence elsewhere. We appreciate the comments on the error and this will be taken into consideration in the next phase of work when we present the model results (i.e., drawdown) to avoid raising confusion for the public.
Abdul Quyum (MOECC)	5	Section 5.1.1.1: Calibration to Higher Quality Wells a) Specific wells discussed in this section should be listed on Figure 8 with the same well identifier as discussed in this section. With respect to difference in simulated vs measured heads, this could well be attributed to inadequate geologic and hydrogeologic characterization. b) The use of pumping wells for simulating modelled heads with the observed heads for the purpose of calibration under steady state conditions is deemed not a good idea because the range within which water elevations varied during pumping was significant. For example, water elevation at F4 varied in the range of 70 m. c) The water elevation data from the Middlebrook well from late 2015 to early 2017 was made available but we could not find a hydrograph comparing the observed water elevation with the simulated water elevation for that duration.	Figure 8 updated to differentiate the various high quality wells listed on Figure 11. We agree that the range of water levels at pumping wells is very large, and as such, we evaluate the calibration at the wells during the pumping test. This is a better assessment of model calibration than steady-state calibration alone. The pumping test used to (transiently) calibrate the model occurred from September 17 2012 to October 28 2012 and this was the calibration period. We did not run the model forward in time to 2015 to 2017 to evaluate the reasonableness with the observed data.
Abdul Quyum (MOECC)	6	Section 5.3: Overall Groundwater Model Calibration Assessment: It is suggested that the model is suitable for making predictions for long-term sustainability of the water supply in Elora and Fergus. This statement should be read in conjunction with the acknowledgement made in section 6 about lack of actual geologic and hydrogeologic information available/collected outside of the Elora and Fergus municipal well fields. Consistent with the inherit limitations of a numerical model which approximates and generalizes several complex geologic and hydrogeologic input parameters, the results from this model for predicting sustainable water supply and climate change induced impact should be considered to be a **best scientific guess.** Actual field work will be required to refine or confirm predictive modelling results. In order to improve modelling results and reduce un- certainties, it is important to a) identify areas within the model domain where information are lacking or require improvements in conceptual site model and b) suggest type of data needed to improve actual input parameters (good quality dedicated monitoring well, pumping test data or long-term monitoring location) and calibration targets.	We agree that the model results need to be viewed with an eye on the model limitations and the quality of the data that went into building the model. We do not believe it would be possible to "confirm" predictive modelling results as the power of the model is to calibrate it to observed time varying conditions and then use the model as a tool to predict future conditions that are years into the future. We would never be able to pump all the Centre Wellington wells at their full capacity at once, in a drought for a 2 year period, but we CAN evaluate those conditions with the model. A section on data and knowledge gaps was added to the report.

Abdul Quyum (MOECC)	7	General Comment: During the technical meeting on March 29, 2018, it was indicated that there was good correlation between simulated and measured heads closer to the municipal wells, i.e. centre of the model domain compared to the model calibration away and toward the model domain boundary. The obvious question is “is it due to unavailability of high quality monitoring well/limited geologic and hydrogeologic input data?” If the answer is yes, then the use of this model to understand and evaluate the effect of municipal pumping at the full permitted capacity in terms of sustainability of municipal water supply could be up for discussion because the municipal well capture zones at full capacity may extend towards the model domain boundary, at least this was the argument made to justify the size of the model domain. The inadequate geologic and hydrogeologic input parameters characterization and unavailability of dedicated high quality monitoring wells outside the Elora and Fergus municipal wellfields and within the modelled capture zones were indicated to be the main reason for the inability of the Golder 2013 groundwater model to assess the sustainability of the Centre Wellington municipal water supply at full permitted capacity. Since the Golder 2013 report, I do not believe additional characterization work has been completed to address concerns noted with the Golder groundwater flow model.	There is good correlation between observed and simulated heads across the study area, but we have the greatest confidence in the area close to the high quality wells. We feel the model IS suitable to evaluate the full permitted capacity/ sustainability at the wells. Initial review of the capture zones suggest they will extend to the model boundary conditions. The Tier Three conceptual model is very different than the previous Golder model which simulated very low K bedrock zones with 2 horizontal high K bedding plane "productions zones". The change is not in the characterization data, but in the interpretation of the geologic and hydrogeologic data.
Ray Blackport (Blackport Hydrogeology Inc.)	1	Calibration of the model for both steady state conditions and transient conditions appear to be quite good	We appreciate the feedback.
Ray Blackport (Blackport Hydrogeology Inc.)	2	I think it would be good, for both an understanding of how the model calibration works and for transparency, to have a bullet summary and a table highlighting the main modifications to achieve the best calibration. This was done by AquaResource for the calibration for specific well fields in the Waterloo Moraine area. I would suggest a memo that highlights the following: • Starting point of the calibration – which they have in the report • Steady-state calibration effort and model refinements – i.e. – what was poor in the initial model run, water levels too high or low somewhere; what was adjusted (modified) and why, with respect to hydraulic conductivity and recharge; what did the modifications do to water levels • Summary table of the adjustments i.e. Kzone ID, layer number and geologic unit, K and rationale • Transient calibration and model refinements to achieve the calibration – i.e. – what was poor in the initial conditions and what was adjusted to provide a better fit; what k zones in what layers were modified to achieve the calibration; did the transient calibration impact the steady state calibration • Provide a summary table of the adjustments to achieve a better calibration and rationale for changes	A section was added to the report document some of the lessons learned with the groundwater flow model calibration. Additional insights could be documented under separate cover for the benefit of the study team and the MOECC.
Ray Blackport (Blackport Hydrogeology Inc.)	3	Note any geographic areas or hydrostratigraphic units that were particularly sensitive to change and areas where additional data would aid in any future refinement of the model	Data and knowledge gaps section was added as suggested.

Ray Blackport (Blackport Hydrogeology Inc.)	4	How well was the correlation in the area where the Guelph model and the Centre Wellington model overlap geographically, especially related to boundary conditions, given that the area of overlap is removed from the main area of interest (and most data) for both models?	Text was added to Section 1.3 of the report to note that there is a reasonable correlation in the deep bedrock units between the Guelph and Centre Wellington models in the overlap area (east of the Grand River).
Ray Blackport (Blackport Hydrogeology Inc.)	5	Can any numbers be presented related to overall water budget – e.g. what flows into the model area and out of the model area; overall recharge, through precipitation, into the model area; gain or loss to the Grand River; leakage into the Gasport formation; and, compare these volumes to the water taking in the Centre wellington area	A water budget section was added to the report as requested.
Ray Blackport (Blackport Hydrogeology Inc.)	6	It might worth highlighting the vertical exaggeration on the cross-sections (for the non-techncial reader) as hydraulic conductivity value changes look so abrupt along the cross-section	Vertical exaggeration was added to the report as suggested.
R.J. Burnside & Associates Ltd.	1	Executive Summary: A statement for reasoning for creating a new model (provided in section 1.3) as opposed to using the existing County model should be provided as this was a primary statement in the terms of reference scope. (Sections 2.2 and 2.2.3)	Text was added to the Executive Summary to address this: "A new model of the Study Area was generated for this assessment for two primary reasons. First, there have been significant revisions to the geologic characterization since the previous numerical model (Golder 2013) was developed. Second, a review of the previously delineated municipal capture zones indicated that the modelled Study Area should be larger than the previously modelled Study Area."
R.J. Burnside & Associates Ltd.	2	Figure 7: The variation in size of circles that represent water consumption do not effectively show the different volumes at each site as the Marsville circle actually looks larger than the Arthur circles.	The dark blue circles show the magnitude of the average annual consumptive rate for the municipal PTTWs. The dark blue circle representing municipal Marsville Well 1 is smaller in size (i.e., lower average annual consumptive rate) than the same circles representing the Arthur municipal wells (i.e., that have larger average annual consumptive rates).
R.J. Burnside & Associates Ltd.	3	Section 3.1 Model Selection: Would be ideal to define what the model mesh is before indicating that the ability to discretize the mesh is a reason for selecting FEFLOW. The meaning of the fourth bullet under this section is unclear.	Text was added to Section 3.1 to introduce the elements/mesh: "FEFLOW utilizes triangular-shaped elements allowing the numerical mesh to conform to numerous irregular (i.e., non-linear) features such as streams or wetlands. The mesh also allows for site-specific refinement of the calculation points in areas where hydraulic gradients are expected to be most pronounced." The fourth bullet was refined to improve clarity to: "advanced boundary conditions (e.g., head boundary conditions constrained to only occur when water discharges at that location) to avoid potential impacts of non-physical boundary conditions on the simulation results."
R.J. Burnside & Associates Ltd.	4	Section 3.1.1 Simulating Bedrock Flow: The use of EPM modelling should be better justified or an indication of the impact of this approach should be provided. If this is a standard industry practice then it should be stated.	The following text was added to support use of the EPM approach: "...EPM is the industry standard for simulating groundwater flow."
R.J. Burnside & Associates Ltd.	5	Section 3.5 Model Layer Type: In this section two simplifications to the model were outlined. It would be beneficial to understand the impact of these simplifications on the model result. Also, it would be beneficial to understand if these simplifications are in keeping with industry standards.	The last sentence in this section was revised to address this: "These simplifications are industry standard (Huyakorn et al. 1986) to avoid some of the non-linearities within the unsaturated zone. These simplifications do not affect computations within the saturated zone but rather they facilitate efficient solution of the water table position."
R.J. Burnside & Associates Ltd.	6	Section 5.1 Quantitative Assessment of Model Parameters; In the quantitative assessment it would be very informative to state how the parameters measured up to the industry standards. For example, the RMS is 6.3 and it is stated an error of +/- 5 m is generally accepted. So why is this number good for the current assessment?	The text describing the RMS error was refined to address this: "This magnitude of residual is reasonable as an error of ± 5 m is generally expected due to errors or uncertainties in well elevation, well coordinates, and seasonal variations in water level elevations that are inherent in the water well record dataset." Similarly, the text describing the MAE error has been refined to this: "This magnitude of residual is reasonable as an error of ± 5 m is generally accepted to be inherent in the use of water well record data, reflecting inaccuracies in well elevation, coordinates, and measurements."

R.J. Burnside & Associates Ltd.	7	Section 5.2 Qualitative Assessment of Model Performance: The report makes use of the terms “reasonable” and “suitably well calibrated” (Section 5.3), these seems to be subjective terms. It may be more suitable to use terminology that reflects the conformity with industry standards which is a less subjective measure.	Text was added to Section 5.3 to address the industry standards: "Quantitatively, simulated hydraulic head and baseflow measurements closely match observed values to achieve a statistical calibration that meets industry standards (Spitz and Moreno 1996)." Five bullets were added to Section 5.3 to further describe the observations that provide confidence in the current interpretation.
R.J. Burnside & Associates Ltd.	8	Section 5.3 Overall Groundwater Model Calibration: This section is of critical importance and could benefit from additional discourse to indicate how the results are in keeping with industry standards for regional modelling efforts.	Additional text describing how the modelling results are in keeping with industry standards is provided in the response to R.J. Burnside comments 4, 5, 6, and 7.
R.J. Burnside & Associates Ltd.	9	Section 8 Groundwater Model Limitations: This section sees like an afterthought in its current position. Suggest that it be moved to much earlier in the document to provide an early indication of the intent of the process and the associated constraints.	We feel the position of this section is appropriate and that the preceding sections are required for adequate context to understand the limitations of the model and recommendations for its intended use.
Frank Brunton (OGS)	1	Comments provided in a memo dated June 30, 2018. The memo is included in Appendix F of the Risk Assessment Report.	Comments were discussed during a Community Liaison Group stakeholder follow-up meeting on August 13, 2018. See meeting summary notes in Appendix G in the Risk Assessment report for a summary of that discussion.

Comments – Centre Wellington Draft Report – Scoped Tier III Study

Date: June 30th, 2018

To: Sonja Strynatka, M.Sc., P. Geo., Senior Hydrogeologist, GRCA

From: Frank Brunton, OGS

Subject: Draft Report – Groundwater Flow Model Development and Calibration Report – Centre Wellington Tier Three Water Budget and Local Area Risk Assessment

---

Hydrostratigraphic Layer Structure

I find the discussion of how Matrix staff constructed or derived the various overburden and bedrock layers (Section 2.1 & Table 2, p. 12) for their model inadequate – especially considering the complex bedrock topography, overburden stratigraphy associated with this topographic relief, and the bedrock stratigraphy. It would be great to relate quality of info available for the key wells with the general review of overburden geology from Burt and Dodge report and various papers I have produced with colleagues for bedrock units.

Karst Section of Report

It would be helpful to see a figure that shows which wells were used to derive the overburden aquifers and aquitards vs the bedrock aquifers and aquitards. I have summarized what criteria were used to create the delineation of predominantly karstic flow zones in Silurian dolostones of Niagara Escarpment in a number of papers in numerous talks since 2009 (see Figure 1 below).

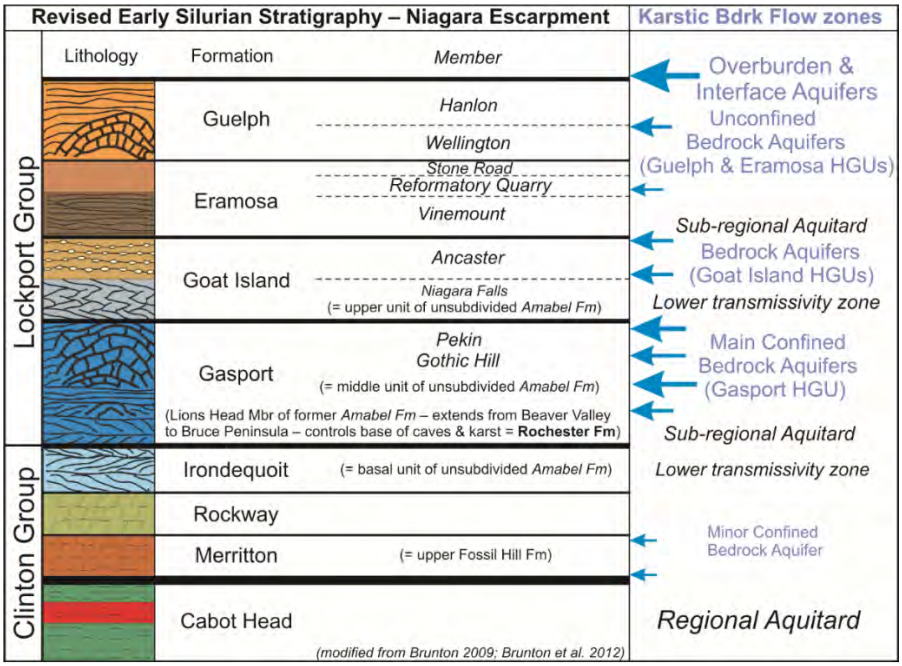


Figure 1. Revised Silurian stratigraphy of Clinton and Lockport Groups for City of Guelph to Shelburne regions (updated from Brunton 2009). Relative thickness of lines separating formations in centre column reflects the significance of diastems (line thickness reflects greater time break). Key aquitards include: Cabot Head Fm; overlying Merritton and Rockway Fms; Niagara Falls Mbr of Goat Island Fm; and Vinemount Mbr of Eramosa Fm. The Fossil Hill Fm correlates with Meritton Fm to south, and the Lions Head Mbr of Amabel Fm corrrelates with part of the Rochester Fm (Brunton and Brintnell 2011; Brunton et al. 2012; Banks and Brunton 2017).

The following sentence is quoted from p. 7 of Matrix report (*These zones are present within the Guelph, Goat Island and Gasport formations at elevations that range from 250 to 380 m asl. Some of these water producing zones within the municipal wells lie at the contact between bedrock formations or members, but most of these zones do not coincide with the contact between bedrock units.*) Note that not all of my main flow zone positions shown in Fig. 1 highlight a karstic flow zone at formational rank contacts. Karstic flow zones may occur a depositional cycle boundaries at contacts between members, etc. I have described some of these facies relationships in different papers – I do not understand why this sentence is even mentioned the way it is here because there are no detailed discussions of where main water-bearing zones have been described from various consultant reports in the study area within the Matrix report.

Also, Matrix argues that an epm approach is defendable/appropriate for this study because discerning the strat/depth positions of all key karst-controlled flow zones in particular wells that have been summarized in a number of the key wells summarized for this study is difficult to map out (see snips of karstic zones that have water flow associated with them from selected wells in study area below – not exhaustive but meant to encourage a more comprehensive discussion in the report).

Just because delineating karst-controlled flow zones is difficult to connect up does not mean that a discussion of such controls is not warranted – especially in an area where a number of the municipal wells and monitoring wells show that flow into the wells in from karstic features. This situation is the same for all karst-controlled bedrock flow systems – I can provide numerous studies and quotes addressing the challenges of mapping/delineating carbonate karst flow systems and summarizing main controls of karst development in Biscayne aquifer system of Florida and numerous other well-known karstic regions. Therefore I believe there needs to be a more thorough discussion of importance of karstic flow zone positions and how hydraulic conductivity estimates were assigned to various hydrostratigraphic layers.

Karstic flow conditions in many of reports for Centre Wellington are described from upper Guelph and/or deeper Goat Island Fm strata and some Gasport Fm stratal intervals. I believe a more thorough summary of the flow profile data and pumping test results from the key reports may help with discussion concerning from where (what depths and strat units) the majority of groundwaters are derived that are pumped from various wells (see main wells in Figure 2).

I have copied a few additional sentences below from section on karst because I wish further elaboration on the statements made. *The size of the fracture apertures noted in the production wells varies, but some apertures are reported to be 1 to 2 cm, when rock fractures are typically on the scale of 0.001 cm.* ***The larger size of the aperture may be due to enhanced dissolution of fractures due to the kinetic energy associated with well pumping.***

There is clear evidence of karst-derived fractures, vugs, voids, large cavities in a number of wells throughout study area. A number of karstic voids/cavities shown in images that follow are much greater than 1-2cm. Note that every bedrock well in carbonates will also have large sections of borehole where no discernible large horizontal or vertical fractures are evident – either karstic or tectonic/neotectonic/structural in origin – this is irrelevant!

Your last sentence that I have bolded implies that we can dissolve tiny bedrock fractures into larger ones through the pumping of municipal wells. I do not believe that the video and optical/acoustic televiewer images of the boreholes in the study area supports this contention or process or possibility! Please provide papers that have demonstrated fracture enhancements associated with the pumping of shallow and deep bedrock wells. The water chemistry of the groundwaters and rates of dissolution

inferred for dissolving dolostones, and in essence undertaking karstic processes, negates this possibility over the time frame of when the wells were drilled – less than 100 years for oldest well. The only enhancement to fracture flow I can see related to pumping a bedrock well in karstic carbonates would be to redistribute partially dissolved rock already present in the fractures or Quaternary sediments that have draughted into the bedrock through some contact with the bedrock surface. This is why some wells are acidified following drilling to basically dissolve the rock flour associated with drilling that may have plugged microfractures in the carbonates. I have not seen any studies that have demonstrated any long-term improvement in well production associated with this acidification process.

Steady State Hydraulic Head Dataset

It would be advantageous to see a more detailed discussion regarding from which wells the 4100 water level elevations were derived (see figure 8 of Matrix report – shows similar well locations to those in Figure 2 below; and info in Figs 7-10). It would be helpful to see how the 10m of groundwater elevation uncertainty was derived.

Does majority of well data relied upon for the modelling exercise show downward or upward gradients in overburden and bedrock?

Below are some sentences taken from report in the Flow System and Water Budget Insights section.

p. 42 – *Much of the groundwater recharging into the ground remains in the overburden and shallow bedrock aquifers and flows toward discharge locations; while a smaller portion (approximately 10%) recharges the deep bedrock (i.e., Goat Island and Gasport formations) flow system.*

If this is the case why are the majority of municipal and private wells deep in bedrock? The wells where karstic groundwater flow has been delineated in upper Guelph Fm bedrock does not generally display upward flow or confining flow conditions – but a number of wells in deeper Goat Island and Gasport do show upward gradients and flow profiling shows little or difficult-to-discern additions of bedrock groundwaters to the open borehole except where particular karstic conduits (fractures or rings or openings) are encountered.

Further elaboration on how the Matrix model was used to approximate the age of various groundwaters would be helpful as would clarification of statements made in the cross-boundary flow section on page 43. Some of the consultant's reports demonstrate that surficial waters (rain and snow runoff) infiltrating the variably thick overburden in study area can/may reside there and not infiltrate deeply into the bedrock – and if such waters do enter the variably karstic upper Guelph Fm, which forms the topmost dolostone unit throughout the study area, it is variably karstic generally in upper 20-55m depths. I have not seen evidence in any of reports of locally derived groundwaters shown to penetrate through the relatively thick Guelph Fm (upwards of 60 to 90ms) into the thinly to medium bedded underlying Goat Island and Gasport fms. Infiltration into these underlying bedrock units is more easily explained as being derived from groundwaters further updip in the Niagara cuesta where these rock units form the subcrop bedrock. None of the bedrock valleys appear to be weathered/eroded deep enough to expose the Goat Island or Gasport Fms – so comparisons with Kunert and Coniglio's papers of Rockwood bedrock valley studies is not well founded. Elaborating on the complex bedrock topography and geology throughout the study area would/may help explain the wide range of groundwater ages mentioned but not discussed in detail.

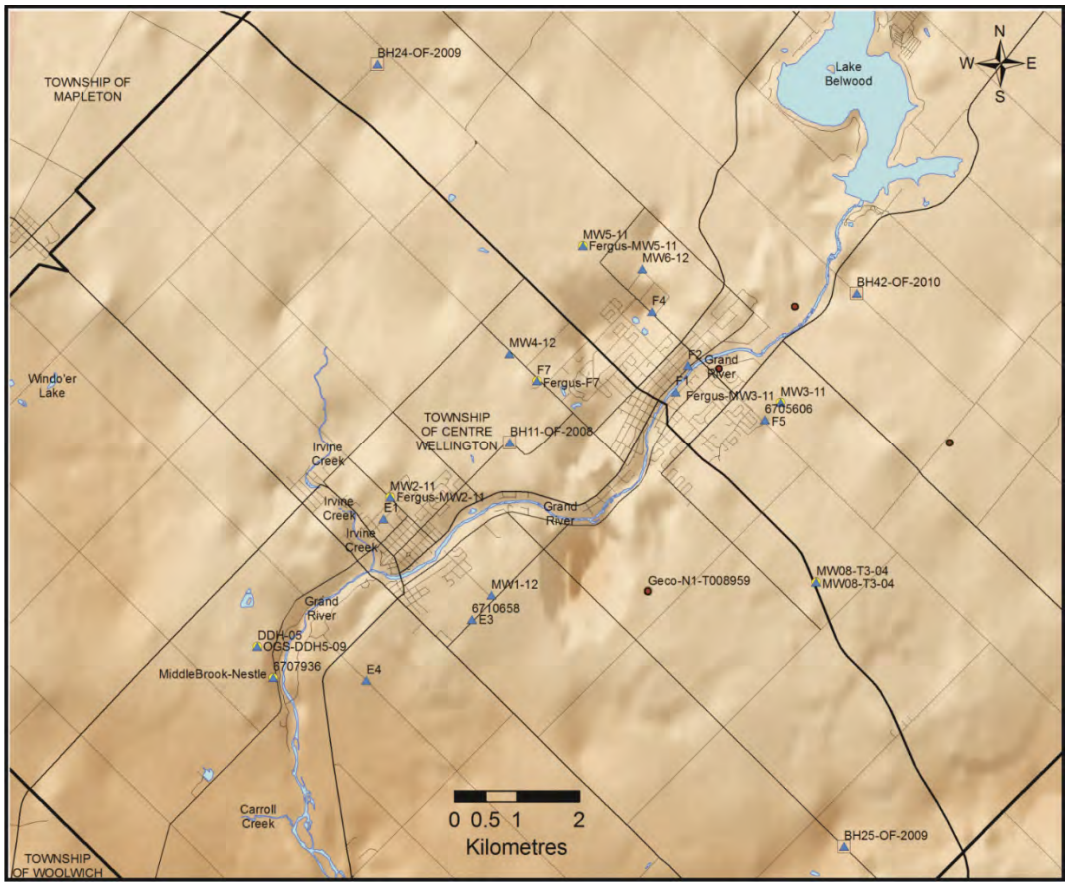


Figure. 2. Location of key wells in study area that have a variety of borehole-based geological and/or hydrogeological data.

One last thing – please provide the well data that supports the aquitard intepretation for the Guelph Fm in areas where the generally inferred aquitards of Eramosa Fm (Vinemount Mbr) and Goat Island Fm (Niagara Falls Mbr) are not present. I am not in disagreement that this formation possesses stratigraphic characteristics that could result in upward gradients of underlying bedrock flow zones or confined flow stratigraphically, but I simply wish to know from which wells you base your statements.

Thank you for considering my comments and requests regarding my concerns with karstic aspects of the bedrock flow systems and bedrock stratigraphic relationships relative to hydrostratigraphic unit designations.

Frank Brunton

Geoscientist

(Groundwater, Basin Analysis, Indi Minerals)

Ontario Geological Survey,

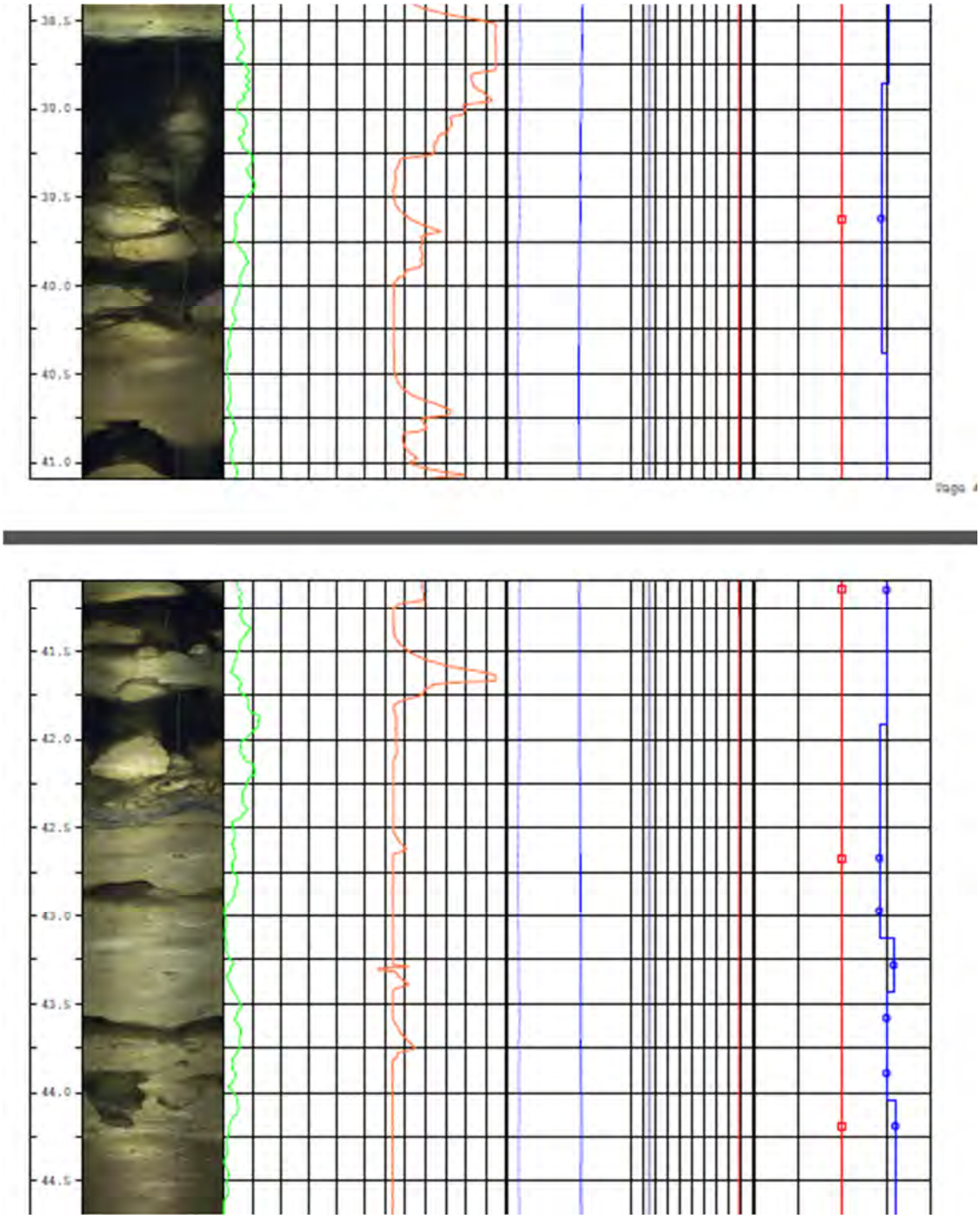
Tel: 1-705-670-5956

Cell: 1-705-920-3775

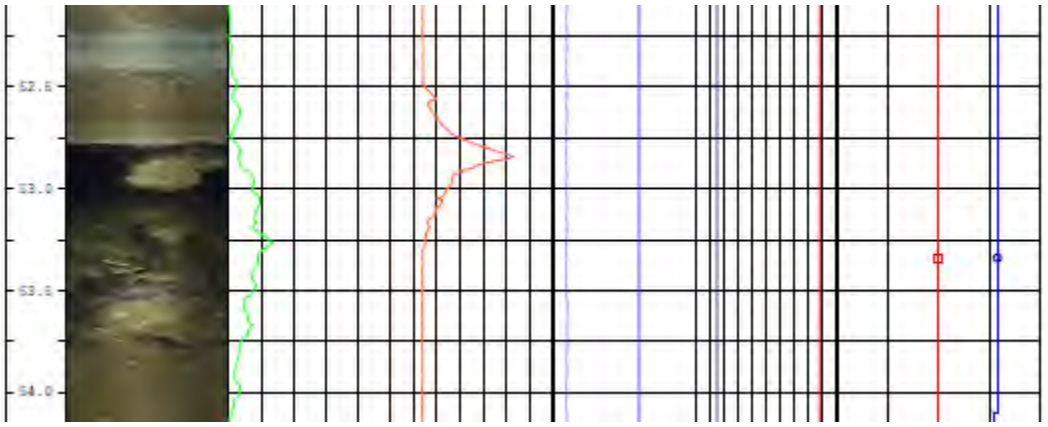
frank.brunton@ontario.ca

Karst features in televiewer logs for Centre-Wellington BHs

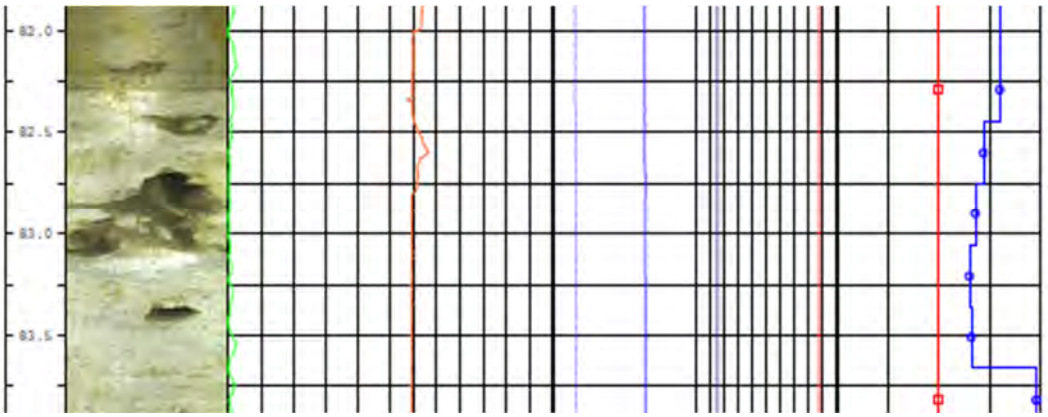
OGSDDH5-09; upper karstic intervals Guelph Fm – 38.6 m to 44.25mbgs. This is not a solution-enhanced fracture that resulted from pumping of municipal wells – as suggested in Matrix Draft report!



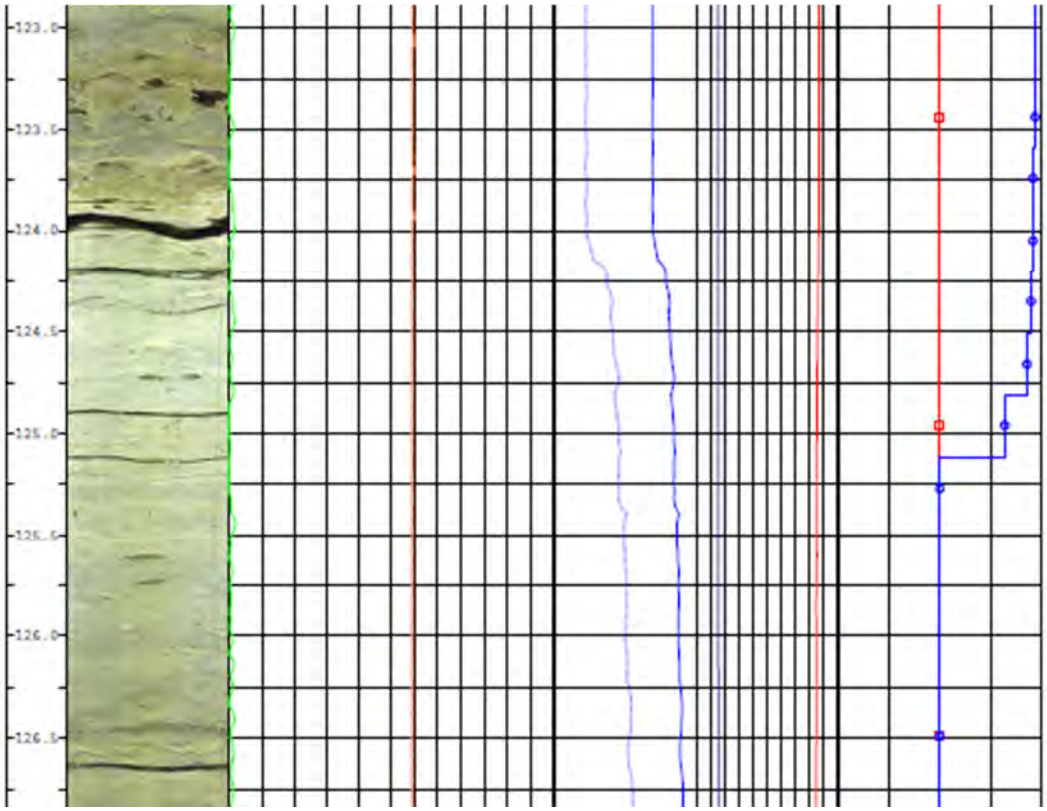
OGSDDH5-09; 2nd karstic interval 52.75m to 53.75mbgs.



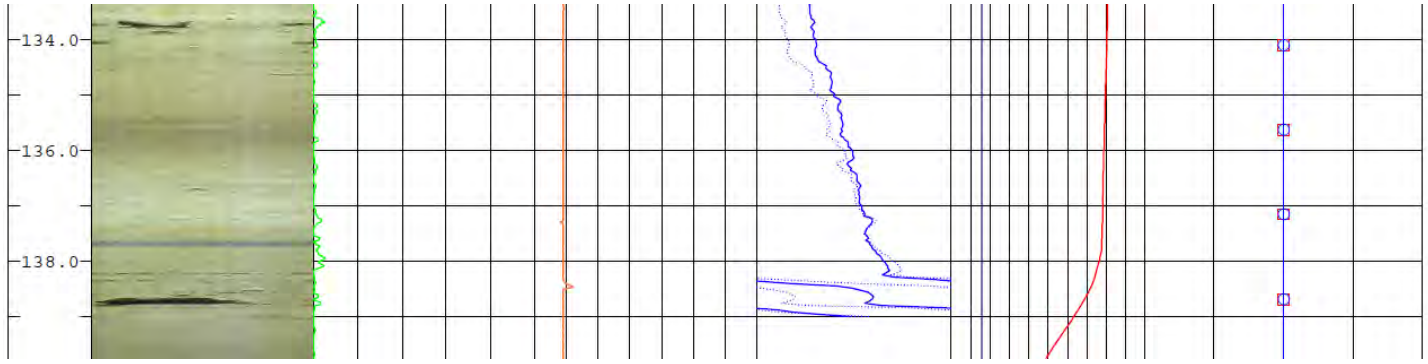
OGSDDH5-09 Karstic interval 82.5m to 83.3mbgs

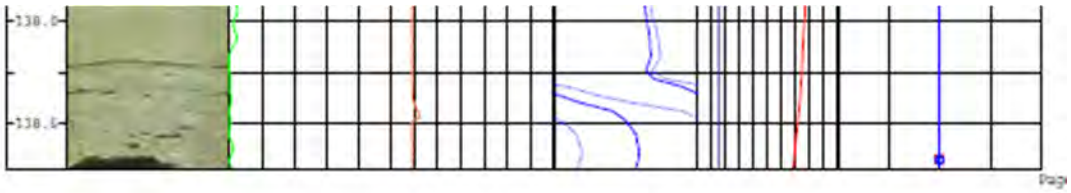


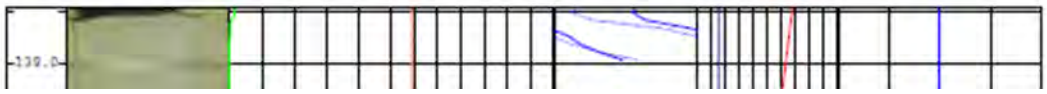
OGSDDH5-09; karstic interval 123.25m to 126.7mbgs-main 124mbgs



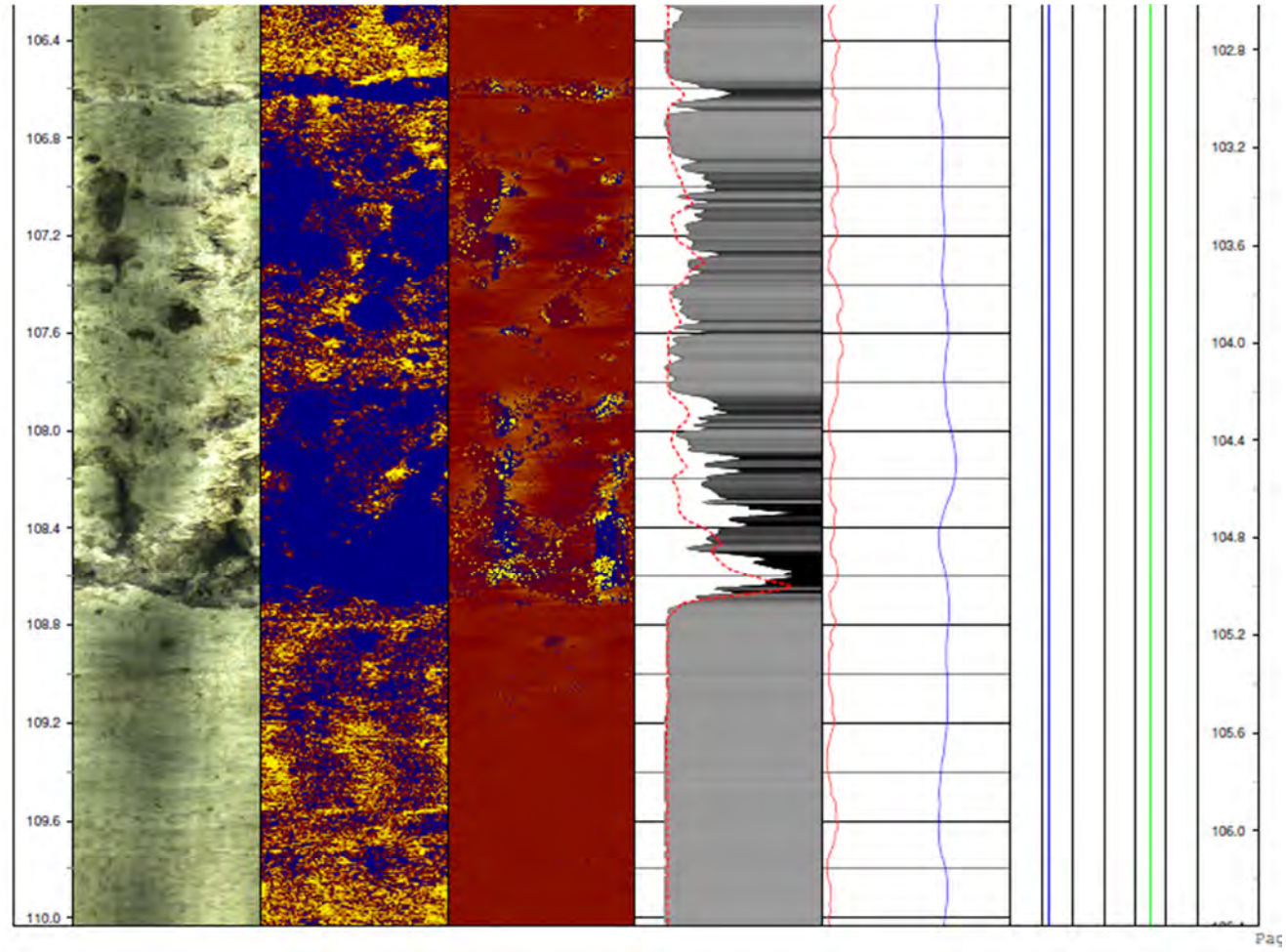
OGSDDH5-09; karstic interval 133.8m and 138. 38m; specifically 138.38 to 138.6 mgbs

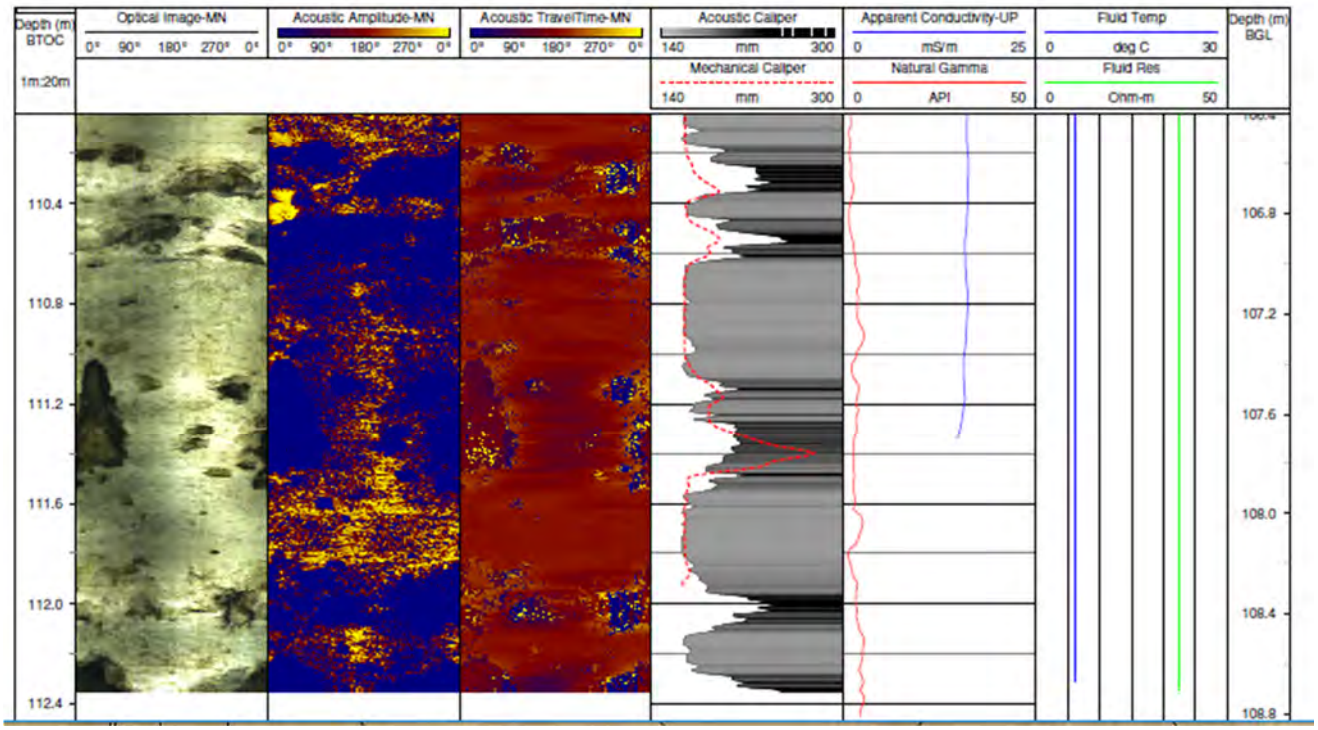






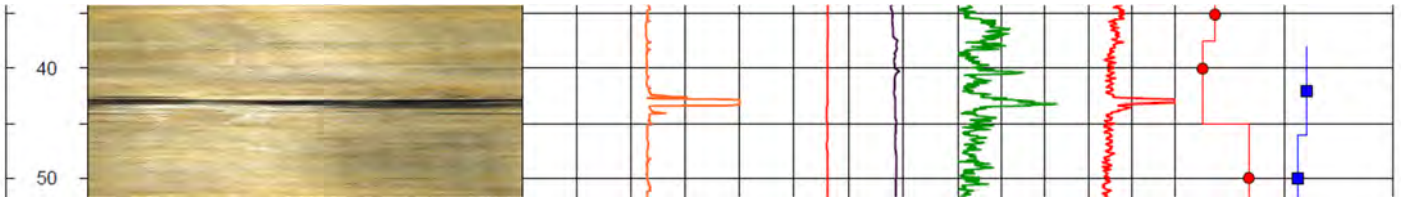
Middlebrook well – basal karstic zone; 196.7m to 112mbgs





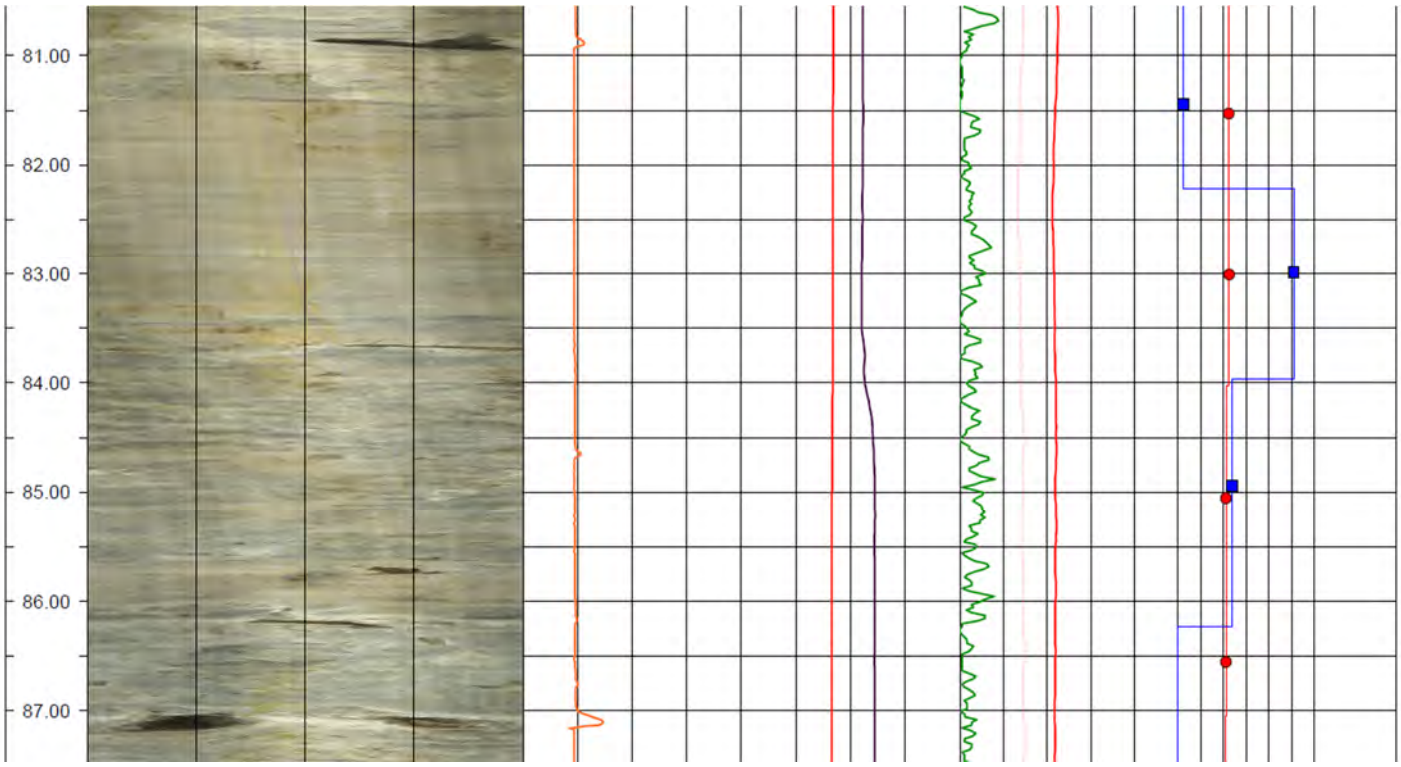
Fergus & Elora wells that display karstic intervals

MW1-12; approx. karstic intervals – 43mbgs

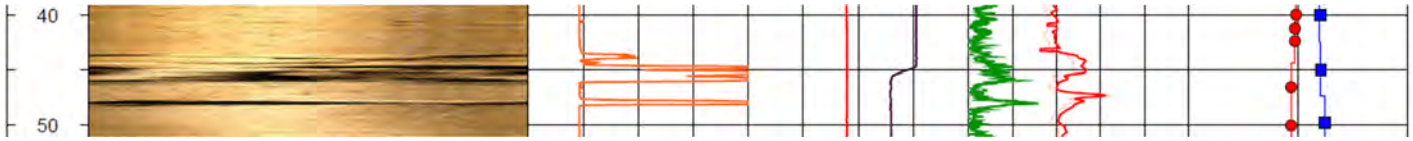


MW1-12; approx. vuggy-karstic intervals – 121 to 132mbgs

MW2-11 – some minor fractures evident in low resolution televiewer log – nothing significant.

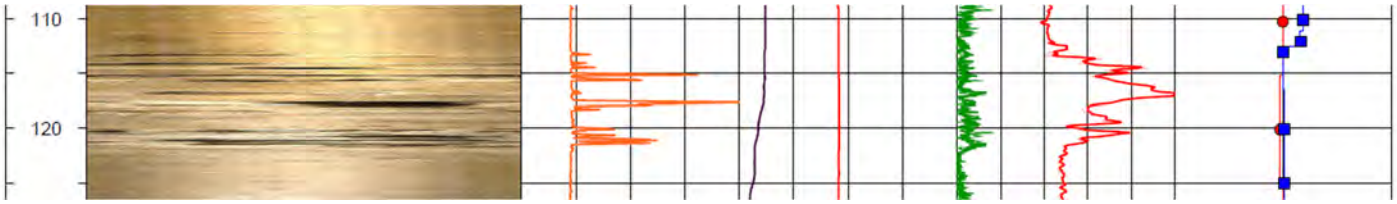


MW3-11; approx. karstic intervals – 44 to 48mbgs

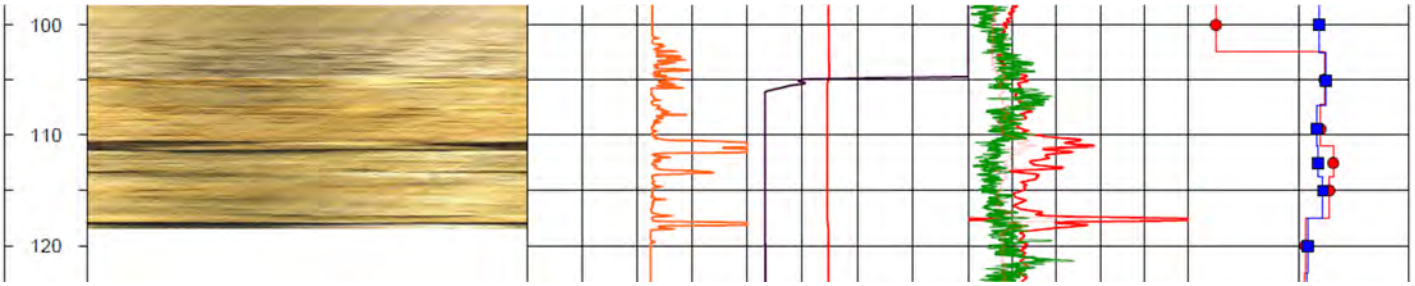


MW3-11; approx. karstic intervals – 82 to 89mbgs

MW3-11; approx. karstic intervals – 113.5 to 122mbgs

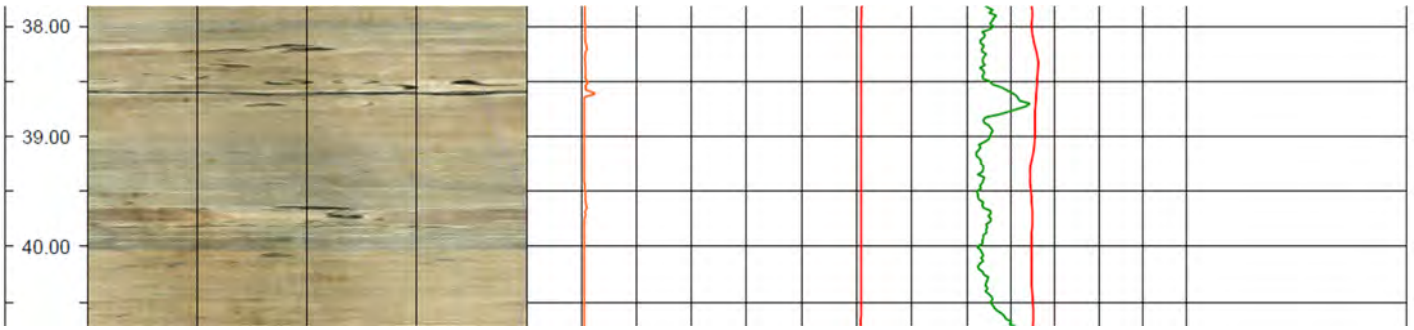


MW4-12; approx. karstic intervals – 110.5 to 118mbgs; note televiewer log ends but not bottom of hole.

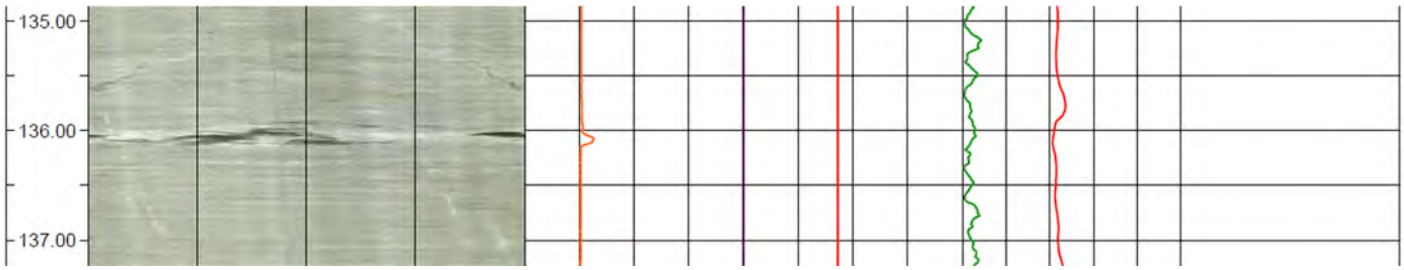


MW5-11; no significant karstic features evident in this televiewer log. Gamma shows Eramosa (115 to 102mbgs) or dirty Goat Island!

38 to 39.6mbgs.



MW5-11; karstic interval at 136mbgs

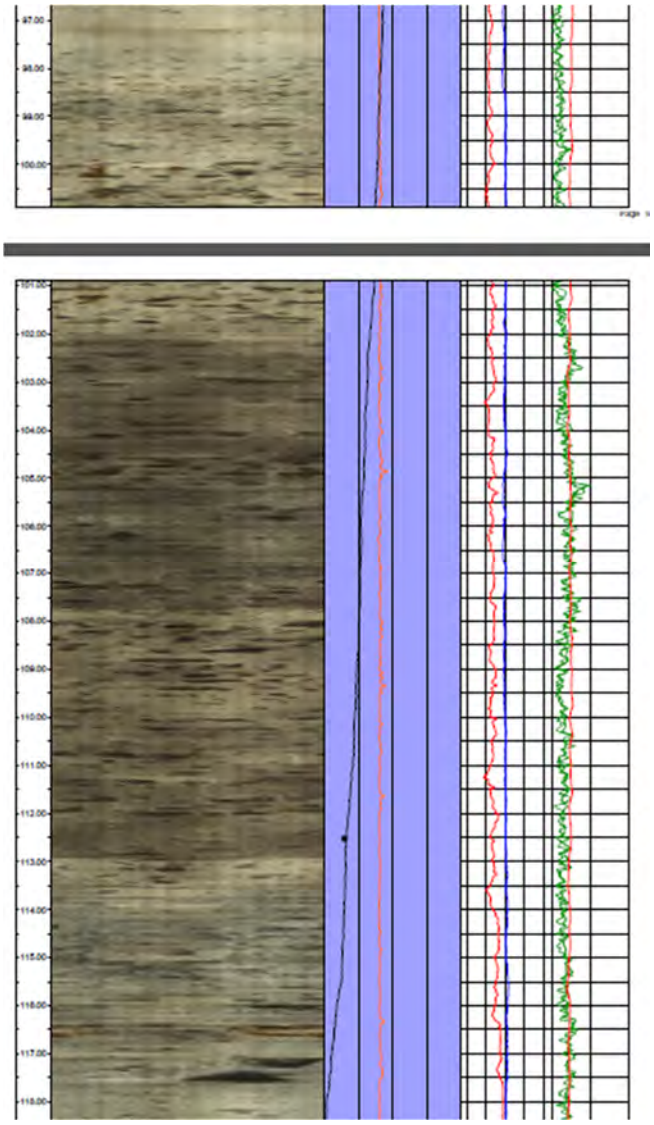


MW6-12; no readily evident karstic intervals.

F1-well; karstic 90percent waterflow 55.5 fracture.

Photo 2: Side view of main water producing feature at 55.5m

F7; televiewer karstic intervals 97.5 to 117.6mbgs.



E3 – 1991 well, two main water-bearing karstic flow zones; 115 m and 123mbgs (base of BH).

Photo 4: Side scan of main flow feature 2

0:40 377.8' 115.2 Horizontal ring feature, water producing zone

0:43 390.9' 119.1 Rock ledge, water producing zone, O-ring

E4 - main water producing zone -- karstic feature base well-125.8 to 128m depth

Photo 5: Likely main water producing feature near base of well with visual flow.

1:31 412.99 125.88 Horizontal ring feature with flow in

1:26 415.22 126.56 Horizontal ring feature with flow in

Local Knowledge Peer Review Comments: Centre Wellington Tier Three Water Budget, Risk Assessment Report

Peer Reviewer	Reviewer Comment #	Report Location	Reviewer Comment	Response
Frank Brunton (OGS)	FB_01	General Comment	all figures presented should be tied to hydrogeological data that supports the interpretations/inferences outlined in the figure.	Where possible, the sources of all data used to create maps in the Characterization, Modelling, and Risk Assessment reports have been discussed. Sources of data of figures contained in the Risk Assessment report generally include model results (WHPA-Q) and boundary conditions, and how those figures have been created is discussed in the report.
Frank Brunton (OGS)	FB_02	General Comment	A table that summarizes K values of overburden layers and bedrock layers in model area (tied to key wells used) and that is tied to reports and well investigations would be appreciated.	New Section 2 has been added to the Risk Assessment report that summarizes the physical characterization documented in Appendix A. Text has been added to new Section 2.3 to highlight where this requested information is available in Appendix A and B: "The municipal wells in Fergus and Elora have been assessed through several water supply studies and pumping tests over the years. In general, the wells have transmissivities that are consistent with typical dolostone aquifers of this area ranging from 52 to 395 m^2/day in Fergus, and 38 to 158 m^2/day in Elora. Table 12 of Appendix A provides a summary of different transmissivity, hydraulic conductivity and storativity estimates derived from hydraulic testing of different wells documented in different studies in the Study Area. These data guided the parameterization of the different hydrostratigraphic layers represented in the Tier Three model. Table 6 of Appendix B summarizes the ranges of field and calibrated hydraulic conductivity values applied to different hydrostratigraphic units represented in the Tier Three model."
Frank Brunton (OGS)	FB_03	General Comment	a few cross-sections that capture depths of known water-bearing units in overburden and bedrock would be very helpful.	Five regional and local cross-sections are provided in Appendix A (Figure 11 - 15). These sections show borehole lithology and depth, well screen intervals, top of bedrock, inferred overburden and bedrock units, and the elevation of observed water levels; however, water bearing zones were not mapped on the cross-sections.
Frank Brunton (OGS)	FB_04	Peer Review Meeting Comment	As a part of the discussion on boundary condition uncertainty, F. Brunton discussed that no wells are located in the northeast portion of the study area in the Gasport Formation. The Gasport changes to the northeast of Guelph where it becomes thin and tight.	The following text has been added to section 3.2.2: "The thickness and transmissivity of the Gasport Formation along the northern boundary of the model is uncertain and will also influence the rate of groundwater flow into the model. This uncertainty assessment does not consider these physical parameters; it focusses specifically on the applied boundary condition."
Frank Brunton (OGS)	FB_05	Peer Review Meeting Comment	F. Brunton would like to see existing data incorporated into the report better regardless of modelling to illustrate how the field data supports the conceptual model.	Section 2 has been added to the Risk Assessment report to provide a review of the characterization work and the characterization report is included in Appendix A of the report. We do not feel that expansion of the Risk Assessment report to include field data is warranted while the characterization report is included as an appendix.
Frank Brunton (OGS)	FB_06	Peer Review Meeting Comment	Peer review meeting: F. Brunton requested that the report include a section to recognize the relationship between field inferred and model-inferred data. The conceptual model of vertical leakage should be validated with field data. H.Whiteley suggested to include this in an 'improved knowledge' section of the report. The group also suggested a section on how the assumption of vertical leakage was arrived at.	Additional text from Appendix B was brought forward to Section 3.1 of the Risk Assessment report. This text discusses how the ability of the numerical model to represent observed hydrogeological conditions confirms that the hydrogeologic interpretation is reasonable and consistent with the available data. The first bullet of that text speaks to the match to vertical gradients: "Simulated groundwater levels are generally consistent with measured values. This is evident through matching of observed horizontal gradients (e.g., contour maps) and vertical gradients (e.g., at observation well pairs or multi level installations)." An additional discussion of vertical leakage through the Upper Guelph is provided in Section 7.3 in response to Peer Review comment HW_11 (Appendix E) and is relevant to this comment as well. Please see that response for additional information. Recent studies/knowledge is summarized in new Section 2.4 and a recommendation has been added that this regional conceptual model for karst could be used to refine the characterization in the future.

R.J. Burnside & Associates Ltd.	RJB_01	Executive Summary	The Executive Summary is likely the primary source of information for the non-technical reader of this report, including staff and elected officials in the neighbouring municipalities. With this in mind, we recommend that a less technical summary be provided to inform the reader on the history, current study results and key recommendations. The key results from previous reports should also be included.	The GRCA will be preparing a less technical summary of the results of the Centre Wellington Tier Three Assessment for the general public. For completeness, a summary of Appendix A (characterization report) has now been included into the report Executive Summary.
R.J. Burnside & Associates Ltd.	RJB_02	Executive Summary	The Executive summary does not mention any of the neighbouring Wellington County municipalities that were included in the study area. It would be helpful for staff and elected officials from these communities if the results of this study that are significant to their communities could be included in the executive summary so that they do not need to search through the entire technical report. This is especially important for the Township of Mapleton where a significant portion of the Township including the community of Alma where there are over 100 listed domestic wells is part of the WHPA Q1. The reason the WHPA Q1 extends into the Township of Mapleton should be provided. The fact that the WHPA Q1 does not extend into Arthur and Marsville is also significant for these communities and should be noted.	The extent of the WHPA-Q1 has been described further in Section 7.1.1: "The delineated WHPA-Q1 area encompasses Elora, Fergus, the Centre Wellington municipal wells, and many of the non-municipal takings simulated in the Study Area (Figure 7). The WHPA-Q1 extends toward the west, encompassing non-municipal PTTWs in the west including a relatively larger aquaculture taking (PTTW 3347-84VQV5) that contributes to the extension of the WHPA-Q into a portion of the Township of Mapleton and Township of Woolwich. The WHPA-Q1 does not extend into the vicinity of the communities of Arthur or Marsville or their municipal wells.". Similar text has been added to the Executive Summary.
R.J. Burnside & Associates Ltd.	RJB_03	Section 4.2.1.1 - Existing Demand	The water takings in Marsville and Arthur have been included on a well by well basis in previous reports, however they are addressed in this assessment report in the following sentence: Municipal demands associated with the Town of Arthur (968 m3/day) and community of Marsville (25 m3/day) are also within the Study Area and represented in the Tier Three model; however, as these wells are not the focus of this Tier Three Assessment the 2016 rates compiled during model development were maintained for the Risk Assessment. There are four separate municipal wells in Arthur and Marsville that are in the study area that should be included in this Assessment. The study is obviously focused on the Elora and Fergus area, but the individual water takings should be addressed as per the terms of reference and if they are not included, a much more detailed explanation of why should be provided. We note that each individual non-municipal permitted well (some with water use of less than 10 m3/year) is listed individually in the report. The individual wells in Arthur and Marsville should be detailed so that the reader does not have to reference previous reports.	Table 6 (previously Table 7) has been updated to include the individual permitted and 2016 takings from the municipal wells located within Arthur and Marsville that were represented in the Tier Three model. The text of Section 5.2.1.1 was also updated: "Water demands associated with three municipal wells in the Town of Arthur (Wells 7b, 8a, and 8b) and one municipal well in the community of Marsville (Well 1) are also within the Study Area and represented in the Tier Three model (Table 6).."
R.J. Burnside & Associates Ltd.	RJB_04	Section 4.2.1.1 - Existing Demand	We note that the largest water taking in the study area is a private system at the Alma Research Station. The water taking is listed but is not mentioned elsewhere in this report. Considering this is a quantity risk assessment we recommend some mention of this taking and significance in the model. The geology in this area seems to indicate unconfined granular deposits directly overlying the bedrock. Although we have already commented and accepted the conceptual model in 2018 the current WHPA should be interpreted with respect to this taking.	PTTW labels have now been added to Figure 7 and mention of this permit has been made in Section 7.1.1 and the Executive Summary as it relates to the extent of the WHPA-Q (see response to comment RJB_02). Additional evaluation of the relative impact of individual non-municipal PTTWs is beyond the scope of the Tier Three Assessment. The relative impact of groups of non-municipal PTTWs, or individual PTTWs, on water level decline at municipal wells may be assessed further as part of a Risk Management Measures Evaluation Process (RMMEP) that may be initiated based on the results of this Tier Three Assessment. A RMMEP involves using the Tier Three model to rank the relative impact of individual or groups of water quantity threats on the municipal wells and then evaluate possible measures that may be implemented to reduce the Water Quantity Risk Level in the vulnerable area. A recommendation to conduct a RMMEP following the Tier Three Assessment is provided in the Executive Summary and Section 9.3.

R.J. Burnside & Associates Ltd.	RJB_05	Section 2.2 - Model Uncertainty Assessment	This section seems to be a continuation of Section 7 of the Groundwater Flow Model Development and Calibration Report and seems out of place in the Risk Assessment Report. While the work described in this section may have taken place since the Development and Calibration Report was finalized, it would make sense to include this information there as it seems to be more relevant to Section 7 of that report and would make the Development and Calibration Report more accurately represent all of the development and calibration measures that were undertaken. It is our opinion that the inclusion of this material in the Risk Assessment indicates that this information is reviewable and hence opens up the remainder of the Development and Calibration Report to further review. As we noted earlier our review assumed that previously reviewed and approved work was no longer subject to review.	We acknowledge this comment and agree that the section may be equally suited to the groundwater model report. However, all three reports can now be considered as part of the Risk Assessment, and the Risk Assessment report uses the results of the uncertainty analysis to support conclusions and recommendations relating to the reliability of model predictions.
R.J. Burnside & Associates Ltd.	RJB_06	Section 2.2 - Model Uncertainty Assessment	The inclusion of additional “uncertainty assessments” in the Risk Assessment and the language used throughout the report suggests that uncertainty cannot be completely removed. Our review of Section 8: Groundwater Model Limitations of the Development and Calibration Report shows the statement “uncertainty in subsurface hydrogeological continuity and parameters cannot be eliminated.” In recognition of this fact we recommend that the uncertainty assessments not be seen as the determining factor in the use of the model but rather that the report be updated to include a statement on the level of “confidence” that can be assigned to the model and what the model is suitable to be used for based on the level of confidence that can be assigned to it. We note, with specific reference to Arthur and Marsville, that the current modelling was not focused on these areas and therefore the underlying conceptual model and model parameters may be more uncertain in these areas. Any future use of the model to make predictions in Arthur or Marsville will require the inclusion of new information in order to improve confidence in model predictions in these areas. For the remainder of the model domain we note that while uncertainty cannot be completely eliminated future updates to model input parameters and future enhancements in the understanding of the conceptual model will allow for a process of continuous improvement of the model. It is important however to recognise that the model should always be used in support of decisions in a manner that is consistent with its level of confidence. It may be useful to examine the idea of zones of confidence where the confidence applied to the inner modelled area (around Fergus/ Elora) is higher than the confidence applied at the model boundaries.	Groundwater model limitations and a discussion of relative model uncertainty within Fergus and Elora versus areas further away from these towns have been addressed as part of Section 8 of the groundwater modelling report (Groundwater Model Limitations). This section has been brought forward into the main Risk Assessment report (new Section 3.4) in response to this comment and comment RS_8 (Appendix E).
R.J. Burnside & Associates Ltd.	RJB_07	Section 3.1.3- Groundwater Vulnerable Area Delineation	It would be informative to have a figure that illustrates the various drawdown areas that were considered for the delineation of the WHPA-Q1. It is noted that the WHPA-Q1 extends into Mapleton and the rationale for the extension in this area should be elaborated. It is our opinion that the map of drawdown that was considered for the delineation of the WHPA-Q1 may provide insight into this. The provision of this figure is consistent with the approach taken for the WHPAQ1 delineation in the Guelph and Guelph/Eramosa Tier 3. The zones of confidence suggested above may be useful in this scenario in order to understand the data that resulted in the extension of the WHPA-Q1 into Mapleton.	Additional zones of drawdown have been added to WHPA-Q1 Figure 7 along with simulated municipal and non-municipal demands. Text has been added to Section 7.1.1 to expand on the extent of the WHPA-Q1: "The delineated WHPA Q1 area encompasses Elora, Fergus, the Centre Wellington municipal wells, and many of the non-municipal takings simulated in the Study Area (Figure 7). The WHPA-Q1 extends toward the west, encompassing non-municipal PTTWs in the west including a relatively larger aquaculture taking (PTTW 3347-84VQV5) that contributes to the extension of the WHPA-Q into a portion of the Township of Mapleton and Township of Woolwich. The WHPA-Q1 does not extend into the vicinity of the communities of Arthur or Marsville or their municipal wells." Please see response to comment RJB_06 and RS_8 (Appendix E) for response regarding confidence in different areas of the model domain.

R.J. Burnside & Associates Ltd.	RJB_08	Section 3.2 - Risk Assessment Scenarios	The reason for including only a subset of Risk Assessment Scenarios is not provided.	-The text was updated to clarify that: "The Technical Rules summarize all the possible groundwater Risk Assessment scenarios that may be applied in a Tier Three Assessment; these scenarios are summarized in Table 3. ". -Table 3 was updated to also show groundwater Scenarios G(4) and G(5) according to the Technical Rules. -Text was added to Section 4.2 to clarify that "Scenario G(5) was not carried out for this Tier Three Assessment as there is no identified Planned municipal demand (see additional discussion in Section 5.2.1.2).". -Table 4 was updated to maintain consistency with Table 3 and include Scenario G(4). - Text was added to sections 4.2.1 to 4.2.4 to reference Scenario G(4) and provide clarification on what type of pumping was used in the scenarios (average/constant vs. monthly). - To maintain consistency with the Technical Rules, text was revised throughout the rest of the report to clarify that Scenario G(4) was used to assess impacts to coldwater streams and PSWs, rather than Scenario G(2).
R.J. Burnside & Associates Ltd.	RJB_09	Section 4.2.1.1 - Existing Demand	In keeping with a conservative approach and the level of confidence that can be applied to the model, should the demands for Arthur and Marsville be kept at 2016 rates for the Risk Assessment?	2016 municipal rates for the Arthur and Marsville wells were used in the calibration of the Tier Three model and future rates were not estimated. These wells are located a distance from the Centre Wellington municipal wells and they are not within the WHPA-Q. Small increases in pumping to meet the future demands are not expected to change the WHPA-Q and the results of the Risk Assessment.
R.J. Burnside & Associates Ltd.	RJB_10	Section 6 - Vulnerable Area Delineation and Risk Assessment Results	The terms of reference for this project states in Section 3.2 that: For the municipal water sources within the Local Area, the consultant will characterize the sources with respect to their completions details, well maintenance records, operational procedures and maintenance information. The characterization of the municipal intakes will be used in the water quantity risk assessment to assign system Tolerances. The Tolerance of a municipal drinking water supply system is defined as its ability to meet the peak demands of the system, and is required to complete the Water Quantity Risk Assessment. It is acknowledged that the focus of the assessment is the wells in Centre Wellington, however for completeness and to match the expectations of the terms of reference we recommend that this section include some conclusions regarding the municipal supplies in Arthur and Marsville. Additionally, Table 11 (Section 6.2.1) should be updated to include information on the Arthur and Marsville wells.	Section 7.1.1 was refined to include reference to other towns and municipalities: "The delineated WHPA Q1 area encompasses Elora, Fergus, the Centre Wellington municipal wells, and many of the non-municipal takings simulated in the Study Area (Figure 7). The WHPA-Q1 extends toward the west, encompassing non-municipal PTTWs in the west including a relatively larger aquaculture taking (PTTW 3347-84VQV5) that contributes to the extension of the WHPA-Q into a portion of the Township of Mapleton and Township of Woolwich. The WHPA-Q1 does not extend into the vicinity of the communities of Arthur or Marsville or their municipal wells." The Fergus and Elora area was the focus of the Tier Three Assessment and greater effort was given to characterize and simulate conditions immediately surrounding the Centre Wellington municipal wells. While Arthur and Marsville are located within the model domain, these areas are located a distance from where calibration efforts were focused and outside of the delineated Local Area (Groundwater Vulnerable Area). For this reason, reporting of impacts to groundwater levels in municipal wells (i.e., Table 11, now Table 10) as a result of the Risk Assessment scenarios should be limited to the Centre Wellington municipal wells.
R.J. Burnside & Associates Ltd.	RJB_11	Appendix C - Selection of WHPA-Q1 Drawdown Contour	Figure C1 shows the location of monitoring wells that were used to support the selection of the WHPA-Q1 drawdown contour. The wells that were selected were ideally completed in the bedrock and outside the area of influence of existing operating wells. PGMN Well W023-1 located outside of the study area is shown on Figure C1 and a paragraph indicating why this well was not used is provided in Appendix C text. Arthur monitor well WN-MW1-00 is a high quality well that was referenced in the Water Balance Report. It is completed in the contact aquifer and likely represents water levels for the past 20 years although it is close to Arthur Wells 8A and 8B. An explanation why it was not used, similar to W023-1, would be suitable.	Text has been added to Appendix C to address Arthur monitoring well WN-MW1/00: "An additional monitoring well, Well WN-MW1/00, located in Arthur was identified during the characterization phase of this project. Longer-term water level data (i.e., 11 years) was provided for this well by R.J. Burnside Associates Ltd. (Burnside) and is included in Appendix A (Figure D19 of sub-Appendix D). This well was not used in the consideration of the WHPA-Q1 for the Centre Wellington municipal wells as it documented as being completed within the deep overburden (Burnside 2003) and not the bedrock groundwater system. Further, water level data at this well suggests it is influenced by municipal pumping at Arthur municipal wells 8A and 8B and may not represent natural water level variability."

R.J. Burnside & Associates Ltd.	RJB_12	General Comment	Model Context It is understood that the context of the project may have been a special consideration and it may be important to note that within the Groundwater Flow Model Development and Calibration Report or in the current report that this was an extraordinary effort. This may be necessary in order for surrounding municipalities to have confidence that subsequent modelling attempts within their jurisdiction will not necessarily be held to the same requirements for uncertainty assessments and community involvement.	The work that went into the development of the Tier Three model was appropriate to meet the objectives of the current project. It will be up to other parties to decide, given their objectives, what future models/modelling in their jurisdictions might entail. No text has been added to the Risk Assessment Report that assumes what the objectives of future models/modelling in the area may be.
R.J. Burnside & Associates Ltd.	RJB_13	General Comment	From sign-off letter: suggest that the recommendations of the current study be re-ordered to show next steps first followed by the recommended improvements to the model.	The numbering of the recommendations is not meant to infer a preferential order in which they should take place. There is currently no defined sequence for the order of future work.
Ministry of Environment, Conservation, and Parks West Central Region	MECP_01	General Comments	Communication for Dan Dobrin, MECP: Thank you for the opportunity to meet with you, Martin and the Matrix Solutions team on September 30, 2019 regarding our concerns about the Centre Wellington Tier 3 water budget. We thought the discussion was productive and appreciated having the opportunity to review how our concerns were addressed in the revised Centre Wellington Draft Risk Assessment Report (Matrix Solutions Inc., October 2019). We support the efforts by Matrix Solutions to strengthen the discussion of limitations of the report's findings and future application of the model. We had previously identified a number of concerns and are still concerned about the lack of high quality data available to support the development of a model of this scale. We are of the opinion that before the model is finalized it would greatly benefit from the work currently underway and planned and is yet to be completed by the municipality and Ontario Geological Survey. However, as discussed at our meeting, we acknowledge that the model development is consistent with the province's source protection water quantity framework and therefore will be accepted by the province and used to support source protection plan policy development. We request that the Township of Centre Wellington and the Tier 3 project team consider the model's uncertainties and limitations in the development of water quantity policies for the Centre Wellington WHPA-Q.	The September 30th meeting provided for a good opportunity for the MECP to clarify its feedback and recommendations on the Tier 3 water budget. Matrix updated the Tier Three report to address this feedback as confirmed by MECP's correspondance. MECP's remaining comments relating to continual improvement and modelling uncertainty and limitations are consistent with the Tier 3 report recommendations.

APPENDIX G
Community Liaison Group Comment Record

APPENDIX G

COMMUNITY LIAISON GROUP COMMENT RECORD

TABLE OF CONTENTS

Community Liaison Group Meeting #1 - Meeting Summary (November 8, 2016)

Memo: Revised Water Demand and Tier 3 Water Quantity Stress Assessment for the Irvine River Groundwater Assessment Area (November 2014)

Community Liaison Group Meeting #2 – Meeting Summary (September 14, 2017)

Summary of Community Liaison Group Feedback on the Centre Wellington Scoped Tier 3 Water Budget and Local Area Risk Assessment Physical Characterization Draft Report (January 2018)

Erratum – Centre Wellington Scoped Tier Three Water Budget Assessment, Physical Characterization Report (June 2018)

Community Liaison Group Meeting #3 - Meeting Summary (May 15, 2018)

Centre Wellington Scoped Tier 3 Water Budget Study: Discussion on draft Groundwater Flow Model Development and Calibration Report (August 13, 2018)

Centre Wellington Scoped Tier 3 Water Budget Study: Discussion on draft Groundwater Flow Model Development and Calibration Report (September 27, 2018)

Community Liaison Group Meeting #4 - Meeting Summary (November 18, 2019)

Comments on the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report (December 6, 2019)

Response to Nestlé Waters Canada Comments on the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report (March 11, 2020)

Centre Wellington Risk Assessment November 2019: Comments and Suggestions (December 2, 2019)

Response to Jim Wilton (Save our Water) Comments on the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report (March 11, 2020)

Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report, November 2019, Questions and Comments related to the Risk Assessment Report (November 29, 2019)

Response to Jan Beveridge (Save our Water) Comments on the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report (March 11, 2020)

Centre Wellington Scoped Tier 3 Water Budget and
Local Area Risk Assessment Study
Community Liaison Group Meeting #1

Tuesday, November 8 | 7:00 – 9:30 pm
Centre Wellington Community Sportsplex
550 Belsyde Avenue, Fergus

Meeting Summary

Welcome and Opening Remarks

Ms. Susan Hall, the facilitator from Lura Consulting, welcomed Community Liaison Group (CLG) members and thanked them for attending the session. Ms. Hall introduced the facilitation team from Lura Consulting and led a round of introductions. She reviewed the meeting agenda and explained that the purpose of the meeting was to orient members to the Centre Wellington Scoped Tier 3 Water Budget and Local Area Risk Assessment Study process.

The meeting agenda is attached as Appendix A, while a list of the meeting attendees is included as Appendix B.

Role of the Community Liaison Group

Ms. Hall reviewed the mandate, role, and terms and conditions of CLG membership with members as described in the CLG Terms of Reference. She explained that the Centre Wellington Scoped Tier 3 Water Budget and Local Area Risk Assessment (the study) is a detailed scientific undertaking to assess risks to the Centre Wellington drinking water system. Ms. Hall reviewed the list of the key project participants as well as their roles and responsibilities during the study. Ms. Hall also explained that the CLG functions as a forum to facilitate a two-way flow of information between the project team, stakeholders and members of the public within the scope of the Tier 3 study. It was noted that this is the first Tier 3 study to include stakeholder and public engagement in the study process.

CLG members were given the opportunity to ask questions of clarification regarding the terms and conditions of membership as outlined in the Terms of Reference. CLG members subsequently confirmed their interest and agreed to the terms and conditions.

The CLG Terms of Reference is available on the project website: (www.sourcewater.ca/CW-Scoped-Tier3) .

Study Process and Key Participants

A detailed overview of the study process and key participants was presented by:

- Martin Keller, Lake Erie Source Protection Region Program Manager, Grand River Conservation Authority (GRCA);
- Kathryn Baker, Hydrogeologist, Ministry of the Environment and Climate Change (MOECC);
- Colin Baker, Managing Director of Infrastructure Services, Township of Centre Wellington; and
- Patricia Meyer, Senior Hydrogeologist, Matrix Solutions Inc.

A summary of the salient points from the presentation are provided below.

- Mr. Keller welcomed CLG members and reiterated that this is the first Tier 3 Study to include stakeholder and public engagement. He noted that he is looking forward to working with CLG members throughout the study process. Mr. Keller explained that the study team includes staff from the GRCA, Township of Centre Wellington, Wellington Source Water Protection, Matrix Solutions Inc. (project consultants) and Lura Consulting (third-party facilitator). The project team is responsible for undertaking the Tier 3 Water Budget for drinking water systems in the Township of Centre Wellington with funding provided by the MOECC.
- Ms. Baker outlined the province's interest in the study and explained that a water budget completed previously for the watershed resulted in a high level of uncertainty regarding the sustainability of municipal drinking water in the Township of Centre Wellington due to growth and future takings. The Tier 3 study is being completed at the direction of the Minister of the MOECC, and is viewed as an important project to enhance knowledge of water resources in the area.
- Mr. Keller explained that an independent review of the technical results of the Tier 3 Water Budget will be completed at each major milestone in the study process by a provincial peer review team comprising the following individuals:
    - Christopher J. Neville, S.S. Papadopulos & Associates Inc.;
    - Dr. David L. Rudolph, University of Waterloo; and
    - Dr. Hugh R. Whiteley, University of Guelph.
- Mr. Baker provided an overview of the Township's water storage and distribution system noting that it includes four elevated storage tanks, nine wells, operation and maintenance infrastructure (e.g., water vales, fire hydrants and watermains), and a booster pumping station that has the ability to move water between Fergus and Elora to keep up with fluctuating demand. The system operates within the context of the provincial legislative and regulatory framework for the Safe Drinking Water Act.
- He noted that it is estimated that by 2041 the Township will have to accommodate 20,425 more people and 10,810 more jobs. This growth will likely take place within serviced areas of the Township.

- Ms. Meyer reviewed the study process and how groundwater modelling is completed first at a conceptual understanding level and then using a mathematical model. She noted that a water budget is prepared to quantify the volume of water entering, moving through and leaving an area to ensure communities can plan for occasions when they have least amount of water available, such as long term drought conditions.
- She also explained that the purpose of the study and desired provincial and municipal outcome is to determine whether the Township's water resources are at risk (i.e., can keep pace with current and anticipated water demand) and to develop a tool that can be used by Centre Wellington to make more informed decisions about managing their future water resources.
- Ms. Meyer noted the study includes four components and three deliverables:
    1) Background Review and Data Collection,
    2) Physical Characterization and Report 1,
    3) Groundwater Modelling and Report 2,
    4) Risk Assessment and Report 3.

  The study is still in the early stages of the Background Review and Data Collection.

- The study components are sequential and require provincial peer review and sign-off before work on the next component can begin. The CLG will be given the opportunity to provide input during each of the three phases (i.e., physical characterization, groundwater modelling, and risk assessment).
- Mr. Keller advised CLG members that meeting materials (e.g., agenda, meeting summary, presentation, etc.) will be made available through the project website. Questions or comments from CLG members between meetings are to be directed to Mr. Keller.

A copy of the presentation is included as Appendix C.

Facilitated Discussion

Questions of Clarification

A summary of the questions of clarification is provided below. Questions are noted with **Q**, responses are noted by **A**, and comments are noted by **C**. Please note this is not a verbatim summary.

Q1. How does a risk assessment differ from a risk management evaluation? Is the evaluation another step in the process?
A. Yes, a risk management measures evaluation is one of the steps in the source water protection water budgeting framework. If a Tier 3 risk assessment identifies a risk to the local area's water supply, the model developed during the Tier 3 study is used to complete a risk management measures evaluation project to simulate different measures that could be implemented to mitigate the risk on the municipal water sources. Upon completion of the City of Guelph Tier Three, the City will undertake a risk

management measures evaluation project to identify ways to mitigate the risks placed on the municipal water resources, using tools developed in the Tier 3 Assessment.
A. A risk assessment identifies the problem, whereas the risk evaluation identifies the management solutions that could be implemented to reduce the problem; it is a separate process.

Q2. Is any consideration being given to use Lake Belwood as a municipal water source?
A. At present, the Belwood Lake Reservoir is not considered a municipal drinking water source and will not be included in the study as a municipal drinking water source. Consideration for new water sources would be addressed through a municipal water supply master planning process.

Q3. I understand the study is based on municipal boundaries, but how does the Tier 3 model integrate with other boundaries (e.g., watershed scale)?
A. The selection of the study area and the size of the model domain will be sufficiently large to consider the cumulative impacts of all nearby water takers, including the potential impact of one municipality on another. Matrix Solutions is completing the City of Guelph Tier Three Assessment and ground water flow modelling and predicted water levels from that study will be consulted to guide the application of parameters (values) applied in the Centre Wellington groundwater flow model.

Q4. Will the final report include conclusions about the data only, or will it provide recommendations to Council? How far will the report go in terms of defining the science and giving advice to decision-makers?
A. At this time, funding has been allocated to complete a technical assessment (i.e., identify if there is a risk or not). The long-term objective is to determine how to manage risk if it has been identified. There will be opportunities to discuss what the next steps might be, but we are not there yet.
A. The report will identify gaps in data or key uncertainties which may help the Township or anyone else doing research in the area focus their work.

Q5. Is there a list of technical terms that can be pulled from the Tier 2 study?
A. The Tier 2 study focuses on the Grand River Watershed. It was completed in 2009 and provides context for this study. You are right that the technical terms are likely already defined in another report.
A. The Project Team is also working on developing a list of Frequently Asked Questions (FAQ) that will be updated as the study progresses, and will prepare a glossary of terms.

Q6. [Member of the general public on a private well] Will the data or study results be available to individuals who are not Township staff to help us plan our farming operations?
A. The GRCA is working with the province and other partners to develop a framework to make the technical results from Tier 3 models accessible to different audiences. It is a complicated process and requires some thought about how they are stored, maintained and accessed.
A. As part of the study, Matrix Solutions will produce maps of groundwater levels based on different scenarios (e.g., climate change, land use, projected growth, etc.) which may help answer some of your

questions; the maps will however provide a broad characterization of the study area and are not intended to offer property specific details.
A. The maps also provide Centre Wellington with a tool as they start to evaluate potential new water sources to do predictive modelling about the potential impacts to private wells.

C7. I have observed stakeholder engagement processes evolve over a 30-year period, beginning when civil service completed studies and made decisions without involving stakeholders. It is extraordinary to see the modelling opened up at the front-end of the process to include stakeholder engagement in this study.

Q8. How does the Tier 3 consider other municipal water users such as RMOW and Brantford?
A. The Tier 3 will consider the impact of increased municipal takings on all water users in the area including other permitted water takers and the natural environment. Changes to groundwater discharge into streams, such as the Grand River, and impacts to provincially significant wetlands will be evaluated as a part of the study. The extent of the study area is currently being determined through a review and analysis of available information, and will be sufficiently large enough to evaluate the cumulative impact of groundwater pumping on other water users.

Q9. How does the Tier 3 get implemented?
A. Following the tragedy in Walkerton, the Province passed the "Clean Water Act" that aimed to protect municipal drinking water sources from water quality and quantity risks. From a water quantity perspective, a tiered set of technical studies were commissioned with Tier One representing a high level evaluation of the water budget of the area (water in vs water out) on a broad watershed scale. If the percentage of water being used in that area exceeded the amount moving in by a prescribed amount, then a more detailed study was required (Tier Two study). The Tier Two Study evaluates the components of the water budget on a smaller (subwatershed scale) and the amount of water moving in/ out is refined. The percentage of water being used on the subwatershed scale is compared to the amount available and if the percent used exceeds a threshold, then the municipal water supplies in that subwatershed require a more detailed water budget study (a Tier Three Study).

Within the Grand River watershed, a Tier Two water budget study was completed in 2009 for the entire Grand River watershed through the Lake Erie Region Source Protection Program. The study looked at how water levels change in the watershed under current groundwater withdrawal and climate conditions and future groundwater withdrawal and drought climate conditions. The Tier Two Water Budget study identified several subwatersheds within the Grand River watershed that exceeded the provincial threshold and were classified as having a moderate or high potential for hydrologic stress. Subwatersheds with a municipal water supply system that have a moderate or high potential for hydrologic stress triggered the need for a more refined water budget study – a Tier 3 Water Budget and Local Area Risk Assessment study. Within the Grand River watershed, Tier Three studies were initiated for the Region of Waterloo, City of Guelph, Centre Wellington and others.

Q10. Will corporate data be included and how does it get included (ie Nestle, Highland Pines)?
A. The project team is interested in data from local water takers including geological information, well water levels, and the results of well tests. This information will be used in developing the conceptual model of the area and in calibrating the groundwater model. Every effort will be made to include relevant corporate data in the study. The project team is reaching out to large non-municipal takers through the Community Liaison Group and can also request support from the province to obtain any corporate data to support the study. All data, regardless of the source, will be reviewed and put through a QA/ QC process by the project consultant. Data that is found to be erroneous or inconsistent the conceptual model of the area is removed from the dataset.

Q11. Will this study provide information on the health of our deep aquifers?
A. The study will evaluate the long term groundwater availability within the shallow (e.g., Guelph Formation) and deep (e.g., Gasport Formation) water supply aquifers within and surrounding the communities of Fergus and Elora. This work will assist Centre Wellington staff in their proactive work to ensure the communities have adequate water supplies to meet their water demands, now and into the future.

Q12. Where are the recharge areas for the deep aquifers and what will the Province do to protect them?
A. "Significant groundwater recharge areas" were mapped across Ontario as part of the Source Protection studies commissioned by the Province. In some areas, largely outside the Grand River watershed, policies are in place to protect the quantity of water recharging the groundwater flow system.

In addition, protection for vulnerable areas not directly associated with a municipal drinking water system has been included in the Provincial Policy Statement, 2014, which sets out provincial planning policy for municipalities to incorporate in their Official Plans and planning approvals.

Q13. Will the study help with water conservation?
A. The study may recommend that water conservation measures within the communities of Fergus and Elora be enhanced to help reduce the current and future water demands and help extend the long term sustainability of the water supply aquifers in the area as the communities grow. The data from the study will allow the Township to explore different options for future water supplies such as focusing on well optimization instead of searching for new well locations.

CLG Aspirations and Expectations

A summary of the shared aspirations and expectations discussed by CLG members is provided below.

- Multiple participants were pleased to see stakeholder involvement from the beginning of the study process as well as a commitment to being transparent and learning from each other.
- The group discussed the value of meaningful stakeholder and public engagement as a means to raise awareness about water issues and to generate support for potential solutions to reduce risk in the future.
- Participants discussed the need to use plain and accessible language and terms when describing technical components of the study. The development of a "living" FAQ and glossary was suggested.
- Participants identified a strong interest in making the study results available and accessible to different audiences (e.g., members of the public, interest groups, decision-makers, etc.).
- Participants recognized a diverse spectrum of skill sets, professional backgrounds and perspectives as well as a common interest in water quality and conservation that will enrich the study process. A few participants also conveyed an interest in developing a better understanding of water resources in the area while improving the decision-making tools available to different agencies.
- Participants identified interest in understanding the implications of the study results on various sectors and individuals (e.g., real estate, agriculture, recreational, families, Township, Province, etc.). A few participants expressed particular interest in the area's deep aquifers (e.g., current conditions, sustainability and protection over the long-term) and learning whether the growth targets set by the Province are achievable given the Township's water resources.
- Multiple CLG members shared a willingness to share data and information (e.g., water takings, contacts, etc.) to help advance the project.

Next Steps

Ms. Hall explained that the draft meeting minutes will be circulated to the CLG within two weeks. CLG members agreed to review and provide any comments on the minutes within one week of receiving them. The minutes will subsequently be posted to the project website. The project team and CLG agreed that the group will meet on Tuesday evenings at 6:30; the next meeting will take place in winter 2017 (date TBC).

Appendix A – Agenda

Centre Wellington Scoped Tier 3 Water Budget and Local Area Risk Assessment Study

Community Liaison Group Meeting #1
Tuesday, November 8
7:00 – 9:30 pm
Centre Wellington Community Sportsplex
550 Belsyde Avenue, Fergus

***Meeting Purpose**:*

1) Review the mandate and role of the Community Liaison Group (CLG); and
2) Orient CLG members on the study process, scope and key participants.

AGENDA

7:00 pm **Welcome, Agenda Review and Introductions**
Susan Hall, Facilitator, Lura Consulting

7:10 pm **Role of the Community Liaison Group**
Susan Hall, Facilitator, Lura Consulting

- *Questions of clarification about the role of the CLG or the TOR.*

7:40 pm **Study Process and Key Participants**
Martin Keller, Project Team & CLG Point of Contact
Patricia Meyer, Matrix Solutions Inc.

- *Questions of clarification about the study process.*

8:40 pm **Roundtable – Expectations and Aspirations for this Study**

- *What knowledge and skills do you bring to the CLG table?*
- *Bearing in mind the study scope, what outcomes are you hoping to see for this project?*

9:20 pm **Wrap up and Next CLG Meeting**

9:30 pm **Adjourn**

Appendix B – List of Attendees

A. Community Liaison Group Members

Member	Organization
Andreanne Simard	Nestlé Waters Canada
Chad Hurell	Fergus Golf Club
Colin Richardson	Public Representative
Dave Blacklock	Wellington Water Watchers
David Bevan (alternate for Richard Moccia)	University of Guelph Aquaculture Research Station
David Parker	Public Representative
Derek Graham	Chamber of Commerce
Don Vallery	Highland Pines Campground
Eric Clarkson	Murray Group
Fred Gordon (absent)	Elora Business Improvement Area
Jan Beveridge	Save Our Water
Larry McGratton	Friends of the Grand River
Pete Graham	Landowner
Tom Nudds	Public Representative
Vic Shantora	Public Representative

B. Project Team Members

Core Team	Support Team	Organization
Martin Keller Sonja Strynatka	Ilona Feldman	Grand River Conservation Authority
Patricia Meyer Paul Martin	Jeff Melchin	Matrix Solutions Inc.
Kyle Davis	Michelle Cuomo	Wellington Source Water Protection
Colin Baker		Township of Centre Wellington
Kathryn Baker		Ministry of the Environment and Climate Change
Ray Blackport		Blackport Hydrogeology
Susan Hall	Lily D'Souza	Lura Consulting

Martin Keller
Sonja Strynatka
GRCA
400 Clyde Rd.
Cambridge, On N1R5W6

November 8, 2016

Re: Centre Wellington Their 3

Dear Martin and Sonja,

We have a few questions, if you don't mind. Some of these may be addressed this evening, but others not. We are indeed thankful for your decision to engage the citizenry in this process. While not wanting to make your lives more difficult, it seemed wisest to address questions and concerns right at the start. We will send this letter as an email in order that you can farm some of the questions out to those on the team who could best answer them.

Thank you very much for your time and consideration,

Best regards,

Dave Blacklock

Jan Beveridge

We would like clarification of what this study is. On page 7 of the ToR, "the objective of the assessment is to determine the risk to the Fergus-Elora municipal drinking water system to meet current or planned water demand based on takings, growth, and other water users in the Township. The purpose seems now to have changed to be more of a tool, a model, into which future updated data can be plugged.

1. Since much data (e.g. from a WSMP) is unavailable, when this project is finished, will it be understood that it is not actually finished?

2. How can we access Stephanie Shifflett's revised Tier 2 for the Irvine Assessment Area?

3. *What planning horizons and population figures is this assessment using; is it looking* at planning for 2041?

Questions about data:

4. With Middlebrook pump test data unavailable, will this study have access to prior pump tests and monitoring data for the Middlebrook well?

5. Does the project team have access to monitoring data from the Ontario Geological Survey monitor well on the property beside Middlebrook?

6. Will the Township be able to supply historic well construction details and original and historic static water level data for municipal wells? This key information, which is listed in the ToR as 'available data from the municipality' was not available from the Township at a meeting in October this year.

Concerns about data from the Growth Management Plan:

The Stantec group is using the 'permitted amount' of water that can be taken for each well for the purpose of calculating each well's 'existing capacity' (their calculation is highest peak amount subtracted from permitted amount equaling 'existing capacity'). This is a concern.

7. How are they accounting for those wells with drinking water exceedances (aesthetic) in the analysis of well capacity? Are they aware that some wells are not pumped at permitted capacity due to poor quality?

8. How is capacity measured for wells that show mutual interference, so that increased pumping is not additive?

9. Stantec is aware, but is not factoring in, that the wells have been tested for capacity on an individual basis but have not yet been tested for capacity when pumping simultaneously. With actual pumping capacity of the individual system wells not known, how can the feasibility of the allocated and planned growth be assessed?

10. The GMS is not taking into account the approximately 1 out of 8 households in the Fergus-Elora urban areas that are not on the municipal water system. This situation poses risk to the municipal system, as is a recognized issue in Puslinch township. Should this risk affect the planned growth numbers for the municipal system?

Questions about the conceptual and numerical groundwater models and water budget:

11. We would like certainty that an intent of this study is to identify the recharge area. What geological formations (aquifers) are going to be included in the project and how are the recharge areas going to be found for each?

12. Regarding using the model from the Golder 2013 TCW Wellfield Capacity Assessment, is it understood by everyone that in this study the projected population for the Fergus-Elora urban area was significantly understated?

13. The Golder 2013 TCW model was based on the presence of aquitards between conductive bedrock formations. With pumping from deep aquifers, and sewage treatment plant discharge into the Grand River, in the water budget how do you balance this groundwater consumptive use (QDemand)?

14. What figure is being used in the model as the static water level for the Middlebrook artesian well?

15. How is the Elora Gorge going to be represented in the model?

December 23rd, 2016

Jan Beveridge
Dave Blacklock

RE: Centre Wellington Tier 3

Thank you for your letter provided at the November 8th, 2016 Community Liaison Group Meeting. The letter included a number of questions which you requested be answered. In the following correspondence, the Centre Wellington Tier 3 Project Team has prepared responses to the questions raised in your letter.

We hope this provides some clarification to the process.

Sonja Strynatka, P.Geo.
Senior Hydrogeologist
Grand River Conservation Authority

Martin Keller
Program Manager
Lake Erie Source Protection Region

Since much data (e.g. from a WSMP) is unavailable, when this project is finished, will it be understood that it is not actually finished?

The funding to commence a Long Term Water Supply Master Plan in 2017 was approved by the Township of Centre Wellington Council on November 28, 2016. As the Centre Wellington Tier 3 study progresses, the information developed in this project will provide the Township with a tool to assist with managing and further developing the municipal water supply system and inform the Long Term Water Supply Master Plan. The water budget can be revisited and updated as the Long Term Water Supply Master Plan and other water taking data become available.

How can we access Stephanie Shifflet's revised Tier 2 for the Irvine Assessment Area?

This document will be provided to the CLG members.

What planning horizons and populations figures is this assessment using; is it looking at planning for 2041?

Right now, the study is in the very early stages of data acquisition and review as it relates to developing the geological conceptual understanding of the study area. As outlined in the CLG Terms of Reference, the first two reports that form the water budget study are focused on understanding the geology and

hydrogeology, and groundwater model development. It's not until the third, and final stage of the study, that future population figures are assessed. The Project Team will be closely working with Township staff and planners throughout the project to ensure the most accurate and meaningful population figures are used in the study.

With Middlebrook pump test data unavailable, will this study have access to prior pump tests and monitoring data for the Middlebrook well?

Yes, the Project Team is working to obtain past pumping test and monitoring well data from the Middlebrook well.

Does the project team have access to monitoring data from the Ontario Geological Survey monitor well on the property beside Middlebrook?

The Project Team has a close working relationship with the Ontario Geological Survey, and as the study progresses, we will discuss data availability with the Ontario Geological Survey and other provincial data sources.

We would like the certainty that an intent of this study is to identify the recharge area. What geological formations (aquifers) are going to be included in the project and how are the recharge areas going to be found for each?

To develop an understanding of the geology and aquifers in the Township, the project consultants will gather together all available high quality information. This will include data from the Ontario Geological Survey and surrounding Tier 3 studies in the Region of Waterloo and City of Guelph, along with other local high quality geological and hydrogeological data that is made available. Matrix will characterize overburden aquifers (where present) as well as the bedrock aquifers, which will include the Guelph and Gasport Formations.

As we are still in the data collection portion of the project, the recharge areas for the bedrock aquifers are not well understood; however, our understanding of the groundwater recharge rates will be enhanced and documented in the conceptual model and water budget reports.

Regarding using the model from the Golder 2013 TCW Wellfield Capacity Assessment, is it understood by everyone that in this study the projected population for the Fergus-Elora urban area was significantly understated?

For the Centre Wellington Tier 3 study, population and employment projections will be used based on the upcoming 2017 Growth Management Strategy and consultation with the Township. The Project Team is working to ensure the most up-to-date and accurate data possible is used in the Tier 3 study.

The Golder 2013 TCW model was based on the presence of aquitards between conductive bedrock formations. With pumping from deep aquifers, and sewage treatment plant discharge into the Grand River, in the water budget how do you balance this groundwater consumptive use (QDemand)?

The project consultants are in the process of reviewing data for the project. The project consultants will review all available relevant geological and hydrogeological information to develop a conceptual model that will form the basis of a new groundwater model . The method for evaluating consumptive uses and demands will be presented in the technical reports and presented to the CLG.

What figure is being used in the model as the static water level for the Middlebrook artesian well?

The project consultants are in the process of acquiring data for the Middlebrook well, and the groundwater model has not been developed yet. As the model is developed, an answer can be provided to this question.

How is the Elora Gorge going to be represented in the model?

The project is still in the very early stage of work planning and data collection and the groundwater flow model will not be built until the characterization work is completed. As such, how the Elora Gorge will be represented is not known at this time. Once the model is developed, the Project Team will present to the CLG how the gorge has been represented in the model.

Concerns about data from the Growth Management Plan:

Your questions regarding the Growth Management Strategy have been forwarded to Brett Salmon, Managing Director of Planning and Development with the Township and Krista Walkey, Associate, Stantec.

Memo: Revised Water Demand and Tier 2 Water Quantity Stress Assessment for the Irvine River Groundwater Assessment Area, November, 2014

Prepared by: Stephanie Shifflett P. Eng., Water Resources Engineer, Grand River Conservation Authority

---

In the Grand River Tier 2 water quantity stress assessment, the Irvine River groundwater assessment area was evaluated as a "low" potential for stress under current conditions (AquaResource 2009b). When future water demands were applied to this assessment area the percent water demand increased to 10% and the assessment area was classified as having a "moderate" potential for stress (AquaResource 2009b). This assessment area includes the municipal water supply system for Centre Wellington which serves the communities of Fergus and Elora. Future water demands for the municipal system were estimated based on population projections and current water usage. A more detailed assessment of future water needs was not available during the study, as the municipality was at the preliminary stages of starting a water supply master plan. With the percent water demand at the threshold between "low" and "moderate" potential for stress and future water demands based on simple methodology, it was decided to review the findings of the Tier 2 Stress Assessment with updated water demand values before moving on to a Tier 3 Water Quantity Risk Assessment.

The Irvine River groundwater assessment area is in the northern part of the watershed, Figure 1. The assessment area is 359km^2 and includes the Irvine River, Carrol Creek and Swan Creek watersheds as well as local drainage to the Grand River from Shand Dam to Township Road 60 just downstream of Inverhaugh. The area is comprised of tight till with some glacial outwash and exposed bedrock. The assessment area is predominately used for agriculture. The communities of Fergus and Elora are serviced with a combined municipal system that is comprised of 9 supply wells that draw from bedrock aquifers.

This review of water demand values is only for the Irvine River groundwater assessment area and focuses on reducing uncertainty in both the current and estimated future water demand in the assessment area. Water supply and water reserve calculations were not changed from the 2009 Tier 2 Stress Assessment, and the groundwater flow model was not re-run for this update.

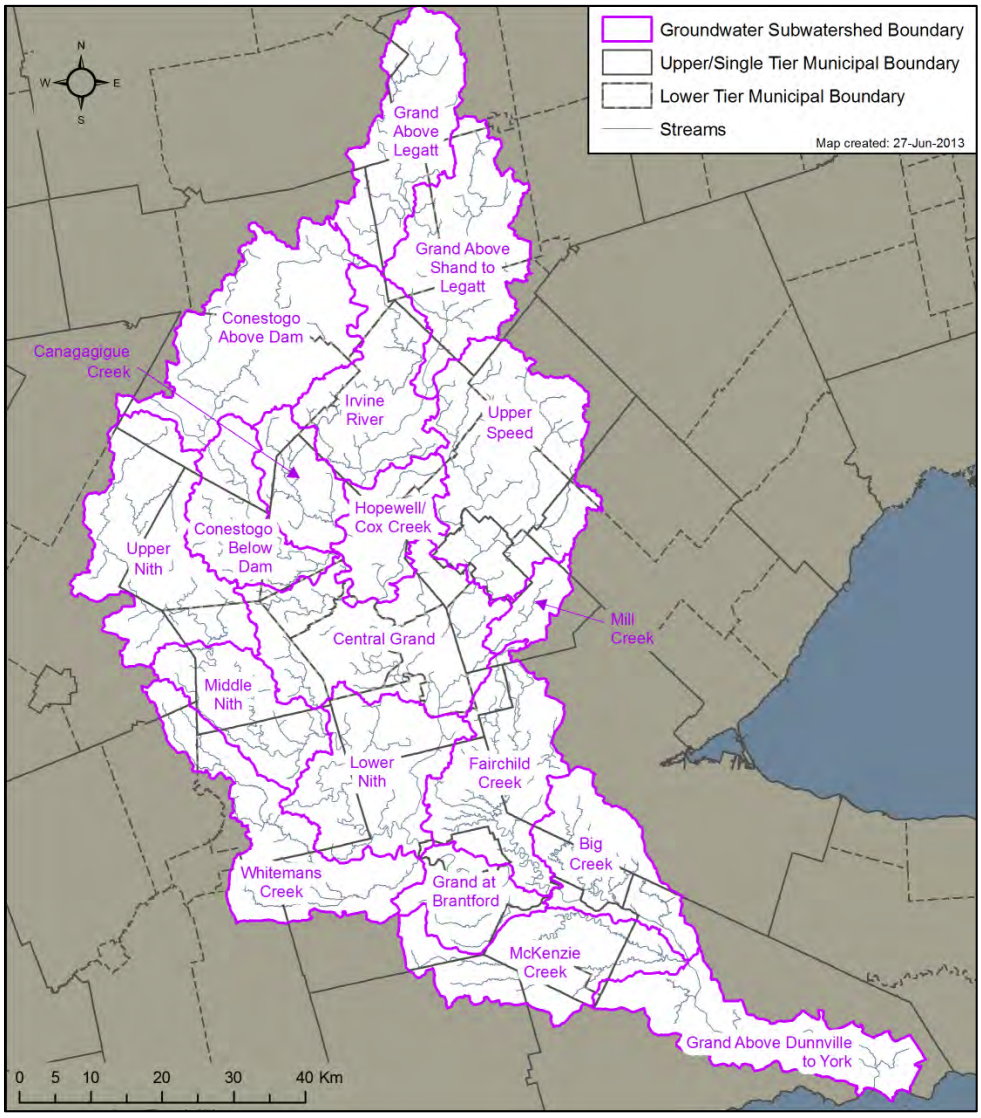


Figure 1: Map showing the groundwater assessment areas in the Grand River watershed

Revised Water Demand

Water demand in the Irvine River Assessment Area in the 2009 stress assessment report had about 20% of the total demand estimated based on maximum permitted water takings with the other 80% based on actual water use numbers. By using the WTRS values from 2009 to 2012 all permitted water takings now have actual water use values attached to them.

Updated values based on actual water use were very similar to the water demand used in the 2009 assessment report. Both values are given in Table 1. The number and types of PTTW also did not change from the 2009 assessment report to the revised values given in this update. The amount of water used for livestock watering and rural domestic was not updated and accounts for approximately

22% of the water demand in the assessment area. Municipal water use was the largest water use with 73% of the total demand. Commercial and industrial uses accounted for 5% of the total demand, while groundwater remediation accounted for less than 1%.

Table 1: Revised monthly water demand in (L/s) for the Irvine River assessment area

Water Demand Estimate	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave	Max
2009 Stress Assessment Report Water Demand														
Reported	60	64	63	73	71	74	67	64	67	67	65	64		
Estimated	14	14	14	14	14	15	15	15	15	14	14	14		
Total	74	78	77	87	85	89	83	79	82	81	79	78	81	89
Revised Water Demand														
Municipal	55	58	56	54	59	57	63	56	59	61	53	56		
Non-Municipal	1	1	1	2	6	9	9	8	6	4	3	1		
Rural/Livestock	17	17	17	17	17	17	17	17	17	17	17	17		
Total	73	76	74	74	82	83	89	81	82	82	73	74	**79**	**89**

Future Water Demand

In the 2009 stress assessment the Irvine River assessment area was classified as a “moderate” potential for stress under future conditions only. Future water use is based on forecast increased water use from municipal sources only. For the 2009 stress assessment water demand for the Irvine River assessment area was projected to increase by 73 L/s by 2031. This value was based on an assessment of current per capita water use within Fergus and Elora, and forecast population projections to 2031. Since the time of the original study Centre Wellington has started work on long term water supply planning. Part of long term water supply planning is to forecast water needs into the future.

Estimates of future water needs were attained from the township and include projected water demands for both average day pumping and maximum day pumping needs. Based on the projections from the township the water supply system is expected to need 64 L/s additional capacity on an average day basis and 75 L/s to meet peak day demands. Average day demands were applied to the average monthly water use estimate, while maximum day demands were applied to the maximum monthly water use estimate. Water use for municipal systems typically peaks in the summer months when outdoor water use is highest so applying peak use to the maximum month (July) makes sense.

Table 2: Future water demand in (L/s) for the Irvine River assessment area

Water Demand Estimate	Future Additional		Future Total	
	Average	Maximum	Average	Maximum
2009 Stress Assessment	73	73	154	162
Revised Water Demand	64	75	**146**	**167**

Groundwater Stress Assessment

Percent Water Demand for groundwater in the Irvine River groundwater assessment area was calculated using estimates of groundwater supply, groundwater reserve, and consumptive demand. Estimates of groundwater supply and reserve have not been changed from the original stress assessment as part of this update. Explanations of how they were calculated can be found in Section 3.3.3 of the stress assessment report (AquaResource 2009b).

Table 3 Revised Groundwater Stress Assessment Irvine River assessment area

Scenario	Groundwater Supply (L/s)			Groundwater Reserve (L/s)	Demand (L/s)		Percent Water Demand	
	Recharge	Flow In	Supply		Average Annual	Maximum Monthly	Average Annual	Max Monthly
Moderate Threshold							10%	25%
Current Demands	1595	58	1653	125	79	89	5.1%	5.8%
Future Demands	1595	58	1653	125	143	164	9.3%	11%

The revised current water demand values resulted in no change to the current demands stress assessment. The Irvine River assessment area remains classified as having a “low” potential for stress under current demands.

The revised future demands values resulted in a slight reduction in the average annual percent water demand from 10% to 9.3%. This reduction changes the potential for stress classification from “moderate” to “low”, but with the value so close to the “moderate” threshold of 10% further discussion on uncertainty and sensitivity is required. There was no change to the maximum monthly percent water demand.

Uncertainty

While the stress classification is based on the best estimates of consumptive water demand, water supply, and water reserve, there is uncertainty with these estimates that may affect the classification. The Technical Rules require that each subwatershed be labeled with having a Low or High uncertainty in regards to the Stress Assessment classification assigned to each subwatershed.

A sensitivity analysis was conducted, similar to the one in the original report, using the revised values for water demand as calculated above. In the sensitivity analysis, there are six scenarios where estimated current consumptive demand, future demand and groundwater recharge for each subwatershed are increased and decreased by 25%. The sensitivity scenarios are completed for both the annual and maximum monthly demand conditions.

Table 4 summarizes the results of the sensitivity analysis for the groundwater stress assessment under average annual and maximum monthly conditions for both current and future estimated demand.

Table 4 Groundwater Sensitivity Analysis

Scenario	Current		Future	
	Average Annual	Max Monthly	Average Annual	Max Monthly
Revised Future Water Demand	5.1%	5.8%	9.3%	11.0%
125% Estimated Water Demand	5.4%	6.1%	9.6%	11.0%
75% Estimated Water Demand	4.9%	5.6%	9.1%	10.5%
125% Future Demand	--	--	**10.4%**	10.6%
75% Future Demand	--	--	8.3%	8.1%
125% Recharge	4.1%	4.6%	7.4%	8.5%
75% Recharge	7.0%	7.9%	**12.6%**	14.6%

The results in Table 4 show that the results are not sensitive to estimated water demand in the future scenarios. This value only includes livestock watering and rural domestic water use and accounts for 22% of the current water use and approximately 10% in the future scenarios. Percent water demand is slightly more sensitive to future demand with a change of about 1% with a 25% change in future water use based on average annual use. Percent water demand values are most sensitive to changes in recharge in this assessment area. A 25% change in the amount of recharge resulted in a 3% change in average annual percent water demand.

Only two of the scenarios resulted in a percent water demand above the threshold of 10%; a 25% increase in future average day water demand and a 25% reduction in recharge with future water demand. An increase in the future estimated water demand of 25% to 80 L/s for average day demand resulted in a percent water demand of 10.4%, but an increase of this much is unlikely given trends for lower per capita water use. It is more likely that average use in the future will be less than the estimate given by the municipality because of more efficient appliances and changing water values. A 25% reduction in recharge resulted in a percent water demand of 12.6% under the future demand scenario. There is confidence in the current recharge values used as they represent a long term average (time period) and were calculated with a model calibrated over a long time period and confirmed with the regional groundwater model. Therefore it is unlikely that they are overestimated by 25%, but it is recommended that any future studies in this area pay particular focus to recharge estimates to further reduce uncertainty.

Conclusion

The revised water demand and percent water demand assessment shows reduced uncertainty in both current and future conditions. For the current condition, the only estimated water use was from unmeasured rural domestic and livestock watering. All permitted water uses were accounted for with multiple years of reported water use data available. Future water use estimates were also refined with values supplied by the municipality from updated water demand planning activities. The inclusion of a separate estimate for average use compared to peak demand is more indicative of current water demand planning, further reducing uncertainty.

Current and future percent water demand values are below the threshold for moderate potential for stress, but the future average annual percent water demand is very close to the 10% threshold. Percent water demand calculations are slightly sensitive to future water use, but are more sensitive to changes in recharge estimates. Based on the sensitivity analysis, a reduction in recharge or a large increase is future water use would bring values above the threshold triggering a need for a Tier 3 Risk Assessment.

Additional studies of water demand and availability in this assessment area should focus on recharge and connections between surface recharge and the bedrock aquifer, where most of the water for the municipal supply is drawn from.

References

AquaResource Inc. 2009a. *Grand River Watershed Integrated Water Budget Report.* Report to the Grand River Conservation Authority, June 2009.

AquaResource Inc. 2009b. *Tier 2 Water Quantity Stress Assessment Report: Grand River Watershed.* Report to the Grand River Conservation Authority, December 2009.

Ontario Ministry of the Environment. 2008. Permit to Take Water Database

Ontario Ministry of the Environment. 2012. Water Taking Reporting System database.

Centre Wellington. 2013. Updated water use planning numbers for Centre Wellington. Provided by: Christine Furlong, Triton Engineering in an email dated March 10, 2014.

Centre Wellington Scoped Tier 3 Water Budget and
Local Area Risk Assessment Study
Community Liaison Group Meeting #2

Thursday, September 14, 2017 | 6:30 – 9:00 pm
Elora Community Centre
29 David Street West, Elora

Meeting Summary

Welcome

Martin Keller, Lake Erie Source Protection Region Program Manager, Grand River Conservation Authority (GRCA), welcomed Community Liaison Group (CLG) members and thanked them for attending the meeting. He recalled the benefit and value of the discussions from the CLG meeting in November 2016 to the project team. He explained that a great deal of work has been completed since the last meeting to prepare the draft Characterization Report and that he looked forward to receiving CLG comments.

Agenda Review, Introductions and Roles

Ms. Susan Hall, introduced herself as the neutral facilitator from Lura Consulting and also welcomed CLG members to the meeting. Ms. Hall led a round of introductions and reviewed the agenda. She explained that the purpose of the meeting was to present and discuss the results of the draft Characterization Report, as well as review the overall study objectives and process.

Ms. Hall provided a refresh of the CLG Terms of Reference, highlighting the CLG's role to offer feedback and observations within the scope of the Tier 3 Study process, and the project team roles. She welcomed members of the public as observers.

The meeting agenda is attached as Appendix A, while a list of the CLG and project team attendees is included as Appendix B. The CLG Terms of Reference is available on the project website.

Presentations

Two overview presentations were given to orient CLG members with updates regarding the Township of Centre Wellington's Water Supply Master Plan and the draft Characterization Report.

(1) Long-term Water Supply Master Plan and Growth Management Strategy Update
Colin Baker, Township of Centre Wellington

Mr. Baker explained that the purpose of the Water Supply Master Plan is to identify and refine additional sources of water in the context of provincial growth targets to the year 2041. He also explained that the master plan will be developed following the provincial Class Environmental Assessment process to outline future water supply alternatives, a preferred water supply strategy with timelines, and recommendations for implementation. Mr. Baker noted the master planning process will include technical work focusing on population and water demand projections and water supply capacity, incorporating modeling completed through the Tier 3 Water Budget, as well as opportunities for public consultation and engagement.

(2) Physical Characterization Report Overview
Patricia Meyer, Senior Hydrogeologist, Matrix Solutions Inc.

Physical Characterization Report
Ms. Meyer began by reviewing the Tier 3 Study objectives, which include: identifying whether Centre Wellington supply wells can meet current and future municipal demands, and estimating the impact of future demand from municipal groundwater pumping on other water users. She also reviewed the four key project components:

1. Data collection and review;
2. Characterization/conceptualization;
3. Groundwater flow model development/calibration; and
4. Risk assessment.

She noted that collecting data and characterizing the physical features of a groundwater system are the foundational steps to building the model that will be used to assess water supplies and identify the threats to the long-term water supplies. Ms. Meyer subsequently presented the process to develop the draft Characterization Report as well as the results, covering:

- The study area;
- Background review and data collection;
- Physical setting: ground surface topography;
- Surface water and ecological features;
- Geology;
- Groundwater flow;
- Water demands (municipal and non-municipal); and
- Water level data.

The key take aways from the draft Characterization Report, as presented by Ms. Meyer, are:

- Revised overburden and bedrock geologic conceptual model developed in collaboration with staff at the Ontario Geological Survey, through the incorporation of all available high quality field data;
- Enhanced understanding of the regional and local geologic and hydrostratigraphic conditions within the study area; and
- Estimation of municipal and non-municipal consumptive water demands across the study area through use of the Province's Permit to Take Water and Water Taking Reporting System datasets, and other data sources.

A combined copy of the presentations is available on the Centre Wellington Scoped Tier 3 web page .

Facilitated Discussion

Questions of Clarification

A summary of the questions of clarification is provided below. Questions are noted with **Q**, responses are noted by **A**, and comments are noted by **C**. Responses with text in italics include further clarification provided by the project team after the meeting. Please note this is not a verbatim summary.

Q. Why does the study area include the Marsville Well if the water from that well runs toward Guelph and not Fergus?
A. *The study area is large to ensure the area where we are making predictions in our future modelling efforts are not influenced by the boundary conditions that may be applied around the perimeter of the model. Previous modelling efforts identified the water quality capture zone for Well F5 extended towards the Marsville area, so we wanted to ensure the model included this area.*

Q. How are gravel pits taken into account?
A. *Any gravel pit that is extracting sand and gravel above the water table will not be considered in the study; however, any gravel pit that is extracting sand and gravel from below the water table, and has a permit to take water (PTTW) will be considered in the study. We are considering them from a water use perspective and evaluating how much water they are taking from the groundwater flow system.*

Q. The poultry farmer should be able to tell you exactly how much water they are taking as they would have those records under Hazard Analysis and Critical Control Point (HACCP); the estimate seems too low.
A. *Staff from the Ministry of the Environment and Climate Change (MOECC) Guelph District Office contacted that particular poultry farmer to request his water demand information. The farmer provided data to the MOECC, which they believe was from the flow meters in the barns and this information was then passed on to the consultant team and entered into the report.*
C. I think it is low. We need to consider seasonal impacts on the water supply.
A. *The study examines water takings on an average annual basis as well as a seasonal basis. We will be running drought simulations where we assess the various water takings on a seasonal basis, and climate change scenarios are forecasted to be run later in the study.*

Q. Where does the recharge to the Gasport formation come from?
A. *The study will evaluate how groundwater flows from the areas to the north towards and into the Guelph, Goat Island and Gasport Formations within the study area. To identify the exact location requires us to build a groundwater flow model of the area. Identifying the recharge area of the Gasport is not yet known; we are still early in the study process and working to answer questions like these.*

Q. Does this report determine future demand?
A. *This report focused on establishing the existing water demands across the study area; future demands (i.e., the water demands for municipal wells in 2041) will be developed in consultation with the Township of Centre Wellington in the coming months, and documented under the Water Supply Master Plan*
A. *We are characterizing the existing conditions within the study area using all available current and historic water level data. This information is used to build the model which will be applied later in the study to answer the "what if" questions about how the groundwater flow system will respond to future stresses like future municipal pumping rates, or seasonal drought conditions. We need to build the model (i.e., the tool) to answer questions about the future conditions.*

Q. Are private wells included?
A. *The amount of water used for domestic water supply in the area around Fergus and Elora was estimated and will be taken into consideration in the study; however, comments on impacts on individual wells is not part of the study. There may be lessons learned that come out of the study (e.g., maps of predicted draw down in the future) that individuals could use to inform themselves.*

Facilitated Discussion #1 – Physical Characterization Report

CLG members were given the opportunity to identify which sections of the draft Characterization Report they wished to focus on as part of this facilitated discussion. A summary of the discussion is provided below and organized by the selected report section. Questions are noted with **Q**, responses are noted by **A**, and comments are noted by **C**. Please note this is not a verbatim summary.

3.1 Municipal Supply Systems

Q. Why is Well F2 included as part of the water supply system given that it has not been used since 2003 (due to surface water getting in) and may not be used again? Why is it considered a municipal supply well? My concern is that it skews perceptions about the available supply of water.
A. *The Township of Centre Wellington has a PTTW issued by the MOECC for ongoing water taking from the well. Well F2 is listed on the permit even though it is currently offline. It is being included in the Scoped Tier Three Assessment because it is a potential municipal water supply well that could be used in the future if treatment were put in place. There are practical reasons why the well is currently not being used; however, the Water Supply Master Plan will assess all wells, including Well F2, in developing long term potential water supply solutions for the Township, and they may, or may not, recommend that the well should be brought back online as a water supply well. The Township wishes to include all potential wells within the study area as options, and not close any doors*.
A. Matrix Solutions Inc. is working closely with the Township and will evaluate the wells that are identified in the Water Supply Master Plan as options.
A. It is not unusual for a Tier 3 Study to assess wells that are currently offline, but could be brought online in the future to help the municipality meet their future demands. As long as there's a permit for the well, the well is included in the Tier Three Study.

Q. Page three of the report states that Centre Wellington pumps 36% of its permitted rate. This implies that 64% is left, which is not correct. That 36% looks at average, but how many days are

actually average? What are the highs and lows? If you look at high-demand days then only 37% of your available water is left. It would be helpful for the general reader to clarify how much water capacity is actually left.
A. *The intent of this study is to determine what you are asking – we want to know how much water can the wells pump over time and will that volume of water impact other water uses such as streams and creeks. It is a cumulative effect study that aims to find out what happens if all the municipal wells and other permitted wells are pumped at a high rate (i.e., what is the impact on other users, future demand, etc.) The line in the executive summary that discusses the permitted rates will be updated to clarify and avoid future misinterpretation of the permitted rates.*

C. Are averages being used to build the model which will then be used to calculate extremes?
A. *The model will look at water demands on an average annual basis as well as a monthly basis when we evaluate seasonal fluctuations. Looking forward, we will also anticipate how much the Township is expected to use on an annual basis. We will also look at peak demands on a monthly basis. For example, in the summer the monthly pumping rates are usually higher and these higher rates will be applied in the model as part of a long-term drought assessment.*

4.2.3. Pathogens and Viruses
C. The report references a study that documents the presence of pathogens and viruses in local water supplies until 2012.
A. The report cites an academic paper by Amy Allen and summarizes the results of her study for information purposes only.
A. The Township received the report in the summer; it is not clear what the study's conclusions mean for the Township. The Township forwarded the study to the MOECC for clarification and will share more information when it is available.
Following the meeting a response to the CLG was provided by C. Baker as included in Appendix C.

Q. Is there not usually a monthly or weekly report about local water quality?
A. Yes, the Township samples and monitors local supplies continuously. The study has raised questions for the Township which is why we referred it to the Safe Drinking Water Branch at the MOECC.

C. Pathogens are the reason that drinking water in Ontario is monitored extensively.
A. *No immediate health issue was identified. The results were reported on raw water and the Township treats their water to remove viruses and pathogens. If there was an immediate health issue it would be dealt with. We want MOECC's clarification about the results of the academic paper.*
C. Water is being drawn from local wells on a large scale; it's an issue and should be addressed one way or another.
A. Please note that the Tier Three study focuses on evaluating the long term water quantity of the Centre Wellington area. The Characterization Report will be updated to note that the Allen paper examined raw water, which is a concern primarily for private wells.

C. Raw water is tested on a continual basis (i.e., every two weeks). I rely on a private well; nothing has been detected in my system or water.

Q. Does that mean the data here is wrong? Should it be deleted?
A. Pathogens and viruses are different from E. coli and total coliforms, which are tested on an ongoing basis. The project team will revisit this section of the report to clarify.

Q. This community is unusual because there are so many private wells within the urban boundary (i.e., approximately 1 in 8 households are on a private well). That is an awful lot of raw water being taken within the urban boundary.
A. Section 3.3.6.1. of the report discusses domestic water takings in the Township of Centre Wellington. We looked at the number of domestic water supply wells within 1 km of a municipal well including the Salem area. We calculated the total number of wells in that area, and used an estimated pumping rate of 251 L/day/house. That equals 230m^3 per day and Salem had another 70m^3. This represents about 2% of the total water permitted use within the study area.

Q. Is there any figure that estimates the amount of water that comes from the deep aquifer versus shallow sources?
A. No, that has not been determined yet.
Q. Will the percentage of water coming from deep aquifers increase over time to 2041?
A. We have not built the model yet to determine the connections between the various hydrostratigraphic units.
Q. Have you determined where the water from the Gasport formation is coming from?
A. We have laid the foundations for the development of the groundwater flow model. We will be looking at the interactions between shallow and deep aquifer using the model as part of the next phase of work.
Q. Where is the water coming from that's in the Gasport formation?
A. Our initial interpretation is that it is coming from the north.
Q. Will the Township need to protect that area? I'm trying to establish if that water source is going to become more important.
A. *Water that is pumped from the municipal wells comes from the Guelph Formation, Goat Island as well as the Gasport Formation. Water flows through fractures in both the shallow and deep aquifers, not just the base of the municipal open hole well in the Gasport formation. Together with Ontario Geological Survey staff, we have characterized the extent and spatial distribution of the Gasport, and the overlying and underlying bedrock formations. We have summarized and compiled the aquifer testing data across the area and we are working to figure out how these pieces fit together.*

Q. I understand you are working with the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) to determine water takings for agricultural use. The pie graph presented shows 2% from agriculture. Can you speak to this?
A. That value was from a large poultry operation, which will be refined as more livestock data becomes available. It also includes water takings for crop and irrigation that have PTTWs.
C. I imagine that 2% will increase when you take livestock into consideration.
A. Yes.

Q. We have a dairy farm and often hear about how much water agriculture uses. How did you quantify the consumptive versus non-consumptive numbers, especially how water reuse/recycling is factored?
A. That slide was included because we want feedback like yours. We're open to hearing how water demand should be or could be evaluated within the study area.
A. Is water use/recycling part of your nutrient management plan?
C. No. We do not have water meters. We know average consumption by animal, but that gets reused and applied back into the land so how do you quantify that? OMAFRA may have some numbers but each farm is different. There is no reporting back to OMAFRA.

A. *If water was taken from the shallow overburden and returned back to the land, that taking would be non-consumptive for that land area. However, as groundwater moves so slowly it takes significant time for water to get back into the bedrock flow system. We are trying to err on the conservative side with our estimates so may assume water use is fully consumptive.*
A. Township staff would be happy to talk about these demands in more detail. The Township is still doing analysis on these agricultural water demands; it's a work in progress so feedback is welcome.

Q. The report timeline references 2031, but significant growth will occur between 2031 and 2041.
A. That is a typo and should be 2041. The project team will address that typo.

Q. What is the timeline for the Water Supply Master Plan? Should we looking beyond 2041?
A. The timeline is to 2041. We do not have employment or population projections beyond 2041 from the Province; we would be guessing.
C. Water plans for the City of Guelph or City of Waterloo have longer timelines (e.g., 35 years).
A. The Township of Centre Wellington staff cannot speak to those plans. They could have longer timelines if they are for water or wastewater treatment plants.

Facilitated Discussion #2 – Tier 3 Water Budget Process Overall
CLG members were given the opportunity to discuss or clarify the Tier 3 Process overall. Ms. Meyer provided a brief overview of the process as no questions were raised.

The next step in the study process will be to build the model and begin simulating water levels and discharges. We still have time to refine or add to the foundation of the model. The focus will be on Centre Wellington wells and the areas around those wells. All of this will be documented in the next report.

Q. When does the public get to comment? Are comments to be directed through the CLG?
A. You can speak to members of the CLG who will bring comments forward to us, or you can speak to members of the Source Protection Committee once the study is presented to them. There will also be an opportunity for formal public consultation before the Tier 3 Study is submitted to the MOECC.

Next Steps

Mr. Keller explained the meeting minutes will be circulated to CLG members for review and posted to the project website in approximately two weeks. He clarified that CLG members may provide separate comments on the draft Characterization Report until October 5, 2017. Mr. Keller also informed CLG members the project team will begin building the model and calibrating it to assess future water demand, as well as answer other questions posed by the group. The model and results will be assessed by the peer review team, and subsequently presented at the next CLG meeting, likely in spring 2018.

Ms. Hall thanked CLG members for contributing to the discussion and adjourned the meeting.

Appendix A – Agenda

Centre Wellington Scoped Tier 3 Water Budget and Local Area Risk Assessment Study

Community Liaison Group Meeting #2
Thursday, September 14, 2017
6:30 – 9:00 pm
Elora Community Centre
29 David Street, Elora

***Meeting Purpose**:*

1) Provide a refresh of the study process, scope and key participants;
2) Review and receive feedback on the Physical Characterization Report; and
3) Address any questions about the process overall.

AGENDA

6:30 pm	**Welcome** Martin Keller, Project Team & CLG Point of Contact
6:40 pm	**Agenda Review, Introductions and Roles** Susan Hall, Facilitator, Lura Consulting
6:50 pm	**Presentations:** **Long-term Water Supply Master Plan and Growth Management Strategy Update** Colin Baker, Township of Centre Wellington **Physical Characterization Report Overview** Martin Keller, Lake Erie Region Source Protection Program Manager Patricia Meyer, Matrix Solutions Inc. Questions of Clarification
7:35 pm	**Discussion #1 – Physical Characterization Report**
8:35 pm	**Discussion #2 – Tier 3 Water Budget Process Overall**
8:50 pm	**Wrap up and Next CLG Meeting**
9:00 pm	**Adjourn**

Appendix B – List of Attendees

A. Community Liaison Group Members

Member	Organization
Andreanne Simard	Nestlé Waters Canada
Chad Hurell	Fergus Golf Club
Colin Richardson	Public Representative
Dave Blacklock	Wellington Water Watchers
David Parker	Public Representative
Derek Graham	Chamber of Commerce
Don Vallery	Highland Pines Campground
Eric Clarkson	Murray Group
Jan Beveridge	Save Our Water
Janet Harrop	Wellington Federation of Agriculture

B. Project Team Members

Core Team	Support Team	Organization
Martin Keller Sonja Strynatka		Grand River Conservation Authority
Patricia Meyer	Jeff Melchin	Matrix Solutions Inc.
Kyle Davis	Emily Vandermeulen	Wellington Source Water Protection
Colin Baker		Township of Centre Wellington
Beth Forrest		Ministry of the Environment and Climate Change
Susan Hall	Lily D'Souza	Lura Consulting

Appendix C – Correspondence

From: Colin Baker [mailto:CBaker@centrewellington.ca]
Sent: Wednesday, September 27, 2017 4:57 PM
To: Sonja Strynatka; Andreanne Simard; Chad Hurrell; Colin Richardson; Dave Blacklock; David Parker; Derek Graham; Don Vallery; Eric Clarkson; Fred Gordon; Jan Beveridge; Janet Harrop; Jim Wilton; Larry McGratton; Lynne Bard; Pete Graham; Richard Moccia; Tom Nudds; Vic Shantora
Cc: Martin Keller; Ilona Feldmann; Emily Hayman; Kyle Davis; Andrew Goldie; Patricia Meyer; pmartin@matrix-solutions.com; Jeffrey Melchin (jmelchin@matrix-solutions.com); Susan Hall (shall@lura.ca); Lily-Ann D'Souza (ldsouza@lura.ca); Ray Blackport (blackport_hydrogeology@rogers.com); Lisa Stocco; Kendra Martin
Subject: RE: Centre Wellington Scoped Tier 3 Water Budget Study - Physical Characterization Report

Good afternoon Scoped Tier 3 Water Budget Community Liaison Group Members,

Further to the September 14, 2017 discussion at the Scoped Tier 3 Water Budget CLG meeting, I promised to follow-up on the Allen et al. Masters thesis, Ministry of the Environment and Climate Change response, and the effectiveness Township's ability to remove pathogens and viruses at each Township water supply well through the chlorine disinfection process. I offer the following response:

All of the groundwater pumped from the Township's water supply wells and the water in the municipal distribution system are treated with chlorine in accordance with Provincial legislation and regulations. Chlorine is the recognized treatment in Ontario for bacteria, viruses and pathogens. The Allen et al. 2017 paper identified detections of viruses in the raw untreated water from certain Township municipal wells. Township of Centre Wellington staff have reviewed the results of the Allen et al. 2017 paper and have consulted with the Ontario Ministry of the Environment and Climate Change's Safe Drinking Water Branch (MOECC). The MOECC's Safe Drinking Water Branch is the provincial regulator for municipal drinking water systems.

As per the Township's current MOECC drinking water license and Provincial regulations, the Township must meet minimum chlorine contact times and minimum free chlorine residual to meet standard treatment of 2 log inactivation or 99% removal for viruses. Following MOECC staff guidance regarding the Allen et al. 2017 results, Township staff reviewed and confirmed the minimum free chlorine residual required for enhanced treatment of 4 log inactivation or 99.99% removal for viruses. 4 log virus removal is an increased level of virus removal, over and above the current standard provincial requirement of 2 log removal. The Township's drinking water disinfection program meets the current MOECC standard for treatment (2 log inactivation or 99% removal) of viruses, and based on our calculations, it also already meets the MOECC's preliminary guidance for the enhanced treatment (4 log inactivation or 99.99% removal) that may be required in response to the findings of the Allen et al. 2017 paper.

It is very important to emphasize that the levels of chlorine used to treat Centre Wellington's drinking water are continuously monitored to ensure both a safe drinking water supply and compliance with Provincial Drinking Water Regulations. The Township's automated alarm level is 0.7 milligrams per litre

(mg/L) for chlorine residual. Any level of chlorine residual below the 0.7 mg/L operating level results in the municipal well being shut down automatically until the chlorine residual is higher than the threshold. This means that untreated or inadequately treated water does not go to the municipal distribution system. This alarm level is termed a "set point" and has been in place for many years.

In summary, the Township's chlorine disinfection treatment meets both the current treatment regulations and enhanced treatment guidance for viruses as recommended by the MOECC. The Township will continue to work closely with the MOECC to ensure the safety of Centre Wellington's municipal water.

Should you have any questions on this issue, please feel free to contact me.

Regards,
Colin

Colin Baker, P.Eng. | Managing Director of Infrastructure Services

Township of Centre Wellington | 1 MacDonald Square, Elora, ON N0B 1S0
519.846.9691 x357 centrewellington.ca

Office located at: 7444 Wellington Road 21, Elora, ON N0B 1S0

Summary of Community Liaison Group Feedback
on the
Centre Wellington Scoped Tier 3 Water Budget and
Local Area Risk Assessment
Physical Characterization Draft Report

Prepared by Grand River Conservation Authority,
Ministry of the Environment and Climate Change,
Township of Centre Wellington,
Wellington Source Water,
Matrix Solutions Inc., and
Lura Consulting

January 2018

Centre Wellington

This page is intentionally left blank.

1 Introduction

Background

The Grand River Conservation Authority (GRCA), with funding from the Ministry of the Environment and Climate Change (MOECC), is managing a Scoped Tier 3 Water Budget Study and Local Area Risk Assessment for the Centre Wellington municipal drinking water system on behalf of the Township of Centre Wellington.

The goal of the Centre Wellington Scoped Tier 3 Water Budget and Local Area Risk Assessment (Tier 3 Study) is to provide a quantitative assessment of current and future risks to Centre Wellington's municipal drinking water sources. The ability of the municipal wells to meet demand will be evaluated under a variety of future scenarios.

Given the growth projections introduced under the *Places to Grow Act* (2005) in the Growth Plan for the Greater Golden Horseshoe (2005, 2017) and the expected increase in water use in the Township, a Scoped Tier 3 Study was initiated in the fall of 2016. The project is being carried out as a "scoped" study as a number of the Risk Assessment scenarios evaluated in other Tier 3 Studies may not be able to be evaluated. Similar to other Tier 3 Studies, this Scoped Tier 3 Study will develop and apply water budget tools that will be applied to support the Township in safe-guarding the quantity of their long term municipal water supply aquifers. Scenarios will be designed and run to identify the potential change in water levels in municipal wells due to: a) new additional (hypothetical) future water supply wells (to be determined with input from the Water Supply Master Plan); b) climatic variability and climate change; and c) reductions in groundwater recharge resulting from future changes in land use development.

The following are the key components of the Centre Wellington Scoped Tier 3 Study:

- Data Collection and Review
- Physical Characterization / Conceptualization of the Hydrogeologic Flow System
- Numerical Groundwater Flow Modelling, and
- Risk Assessment

This study, like all Tier 3 Water Budget studies, is being peer reviewed on behalf of the Province by a team of highly qualified third party technical experts. The Provincial Peer Review Team has met with the Project Team once and will meet with the project team and consultants at least twice more throughout the project. The role of the Peer Review Team is to ensure the project is scientifically defensible, ensure any subjectivity in the project will not result in significantly varying outcomes, and to provide guidance and feedback to the project team at critical milestones throughout the project.

Stakeholder and community consultation is an important component of the Centre Wellington Scoped Tier 3 Study. A Community Liaison Group (CLG) was formed at the outset of the project and the group is comprised of 15 local stakeholders and residents. The purpose of the CLG is to provide feedback and

advice to the Tier 3 Project Team at key milestones in the study, and support efforts to keep the broader community informed about the project and its progress.

A draft Physical Characterization Report was prepared by the project consultant and reviewed by the Provincial Peer Review team in the summer of 2017, representing a key milestone in the project process. The report was updated with feedback from the Peer Review Team and an updated draft report was subsequently circulated and presented to CLG members in the fall of 2017, which generated interest in the form of comments and questions.

Report Contents

This document provides a high level summary or synthesis of the comments and questions submitted by CLG members on the draft Physical Characterization Report. Section 2 provides project team responses to questions received by the CLG and is followed by a brief description of next steps in Section 3.

2 Summary of Community Liaison Group Feedback

The draft Physical Characterization Report was provided to CLG members in the summer of 2017 and time was provided to the CLG to review and comment on the contents of the report before the document was finalized. Six email submissions, containing over 80 broad and detailed questions and comments were received by members of the CLG; the table presented below provides a synthesis of the themes regarding the key questions/issues received and the Project Team responses to those questions.

What We Heard

A few submissions conveyed appreciation for community involvement and the opportunity to provide input to the Tier 3 Study process, and a few others commended the quality of the CLG presentation and the quality of the technical information presented in the Physical Characterization Report. Recurring comments, concerns, questions and input on the draft report, which expand on the questions raised at the second CLG Meeting, have been organized according to the themes below:

- Study Purpose and Process
- Physical Setting and the Study Area
- Water Supply Systems and Estimated Demand
- Municipal Water Quality
- Suggestions to Improve Report Formatting
- Data Requests

Project Team Responses

Key questions/issues raised by CLG members are listed below along with the corresponding response from the Tier 3 Project Team.

Questions / Issues	*Response*
Study Purpose and Process	
What is the purpose of the study?	The purpose of the Scoped Tier 3 Study is to evaluate the sustainability of Centre Wellington's municipal water supply system as it currently operates, and under various changes, such as land development as the population increases, drought, and increased municipal water takings that may occur into the future to the year 2041. The overall scope of the project has not changed, although the budget for the 2017/2018 fiscal year was revised to reflect unforeseen, yet necessary, technical revisions. This included the development of a new groundwater flow model, and the inclusion of the most current (yet-to-be-published) geological data from the Ontario Geological Survey. The project team is dedicated to the development of a groundwater flow model based on all best available current information, and this has taken more time than originally anticipated.
Can additional information on the project scope and Water Supply Master Plan be provided?	The schedule and timelines for this study have varied from those established at the onset of the project. When the project started in September 2016, the Township was not planning to begin their Water Supply Master Plan (WSMP) until after 2019. This has now changed with Township Council approving funding for the WSMP in its 2017 and 2018 Capital Budgets. The Request for Proposals for the WSMP was issued by the Township on December 14, 2017 and closed on January 15, 2018. Until the timelines for its completion are confirmed, the Tier 3 project timelines for the latter parts of the study are in flux. The Tier 3 groundwater flow model will be presented to the CLG in the spring of 2018. Following the completion of the model, a number of scenarios evaluating different stresses on the groundwater flow system will be assessed and the results will be analyzed; this process is referred to as the Risk Assessment. The Risk Assessment portion of the Tier 3 Study will use the groundwater flow model to evaluate stresses to the groundwater system, such as increased municipal pumping, changes in land cover resulting from land use development, drought, and the effects of other large water takers on the water levels at the municipal supply wells. The intent of this study is to follow the prescribed risk assessment scenarios outlined in the Ministry's Technical Rules as closely as possible. However, some of scenarios cannot be completed if the Water Supply Master Plan is incomplete. The Project Team will work closely with its municipal partners to ensure relevant scenarios are developed to assess the potential effects of growth and development on the Centre Wellington municipal groundwater system. The Project Team is working towards the common goal of increased understanding of the Township's municipal water supplies now and into the future, and to better understand what stresses affect the supply and how those stresses can be effectively managed. To begin this process, meaningful scenarios will be developed in consultation with the Township, Province, and consulting teams for the Tier 3 and the WSMP.

To better ensure that the public is made aware of upcoming meetings, it was requested that at least two weeks advance notice of meetings be provided using various forms of communication.	For the first CLG meeting, notice was provided in the Wellington Advertiser and through a Centre Wellington Council meeting. The second CLG meeting was posted on GRCA's Facebook page and released through GRCA's Twitter account. The Township re-tweeted the meeting notice twice prior to the meeting. We acknowledge that updates via social media may not be the way to reach everyone. We will increase efforts to extend the reach of our communications to the general public prior to the next meeting. Members of the CLG are also encouraged to let others in their organization, or other interested individuals in the community know about the meeting on their respective organization's websites as well.
Physical Setting and the Study Area	
How does rainfall make its way to the municipal wells?	Some of the rain or snow that falls to the ground surface seeps into the ground. The portion that flows downwards through the unsaturated (dry) zone and reaches the water table is called groundwater recharge. This water is always moving underground; it moves more quickly through "aquifers" (rocks or soils that transmit water easily) and moves much more slowly through aquitards (rocks or soil that do not transmit water very easily). The rate or velocity that groundwater moves is dependent on the location and characteristics of the aquifer and aquitard layers, but groundwater is always moving. Groundwater continues to move until it enters (discharges) into a surface water feature like a river, stream or lake, or until it is withdrawn from the ground by pumping at a well. The arrows on Figure 1 illustrate the direction that groundwater is flowing from the shallow water table aquifer to deeper groundwater aquifers, including areas where the confining unit (aquitard) is absent, vertically fractured or discontinuous. The source of water for deep bedrock units such as the Gasport Formation deep below the ground in Centre Wellington includes water that flows as part of the regional bedrock flow system (e.g. water originating near the Niagara Escarpment), but there are also contributions of water from the overlying overburden and bedrock aquifers in the area.

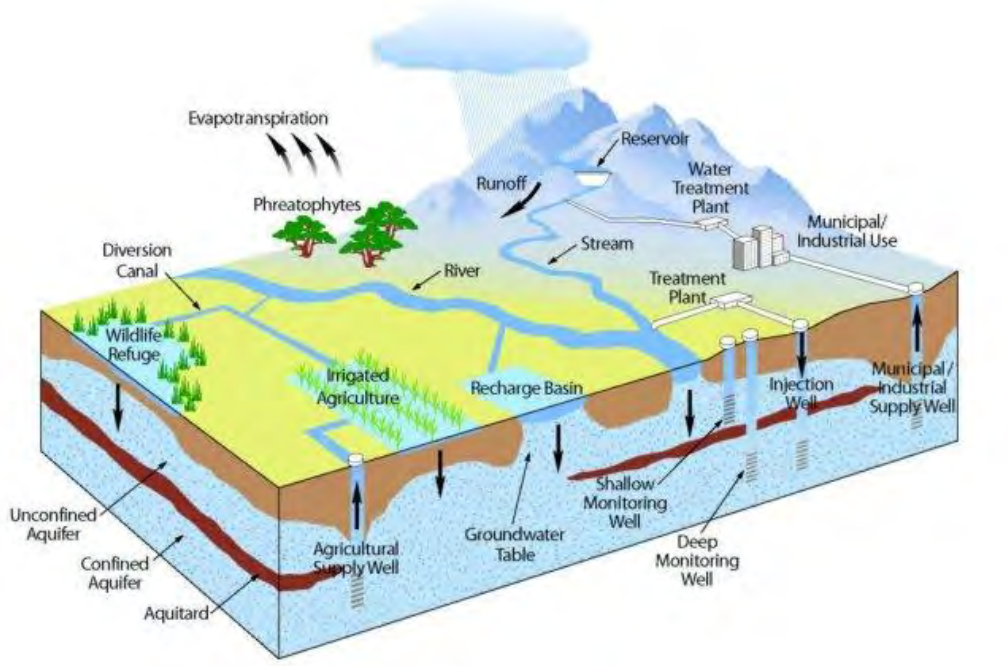


Figure 1: Water Cycle (*from, California Department of Water Resources*)

Computer models are often developed to help evaluate the sustainability of shallow and deep bedrock aquifers. Groundwater flow models are simplifications of the complex subsurface environment yet they provide insight and information on how the groundwater flow system may respond to different stresses without the risk of long term testing in the real world. For example, a groundwater flow model can be used to evaluate; a) the change in the groundwater flow system if pumping from municipal wells is increased to their estimated future pumping rates, b) the effects of long-term drought, or c) the impact of reductions of groundwater recharge in the urban areas due to land use development. Groundwater modelling provides insight on the potential individual or cumulative effects associated with different environmental stresses. It is important to note that the modelling results are not facts; rather, they provide insight into the long term sustainability of the municipal aquifer(s) under various future potential conditions.

Water Supply Systems and Estimated Demand

How are non-municipal water users incorporated into the study?

Recognizing the value of the water demand estimates for this project, water use estimates across the Study Area were estimated using various data sources (Table 1).

Table 1: Water Demand Data Sources

Type	Example	Source for Estimated Water Demand
Municipal - Permitted	Centre Wellington municipal wells	Metered rates from Townships
Non-municipal - Permitted	Aquaculture, golf course irrigation	Water Taking Reporting System
Non-municipal - Permit Exempt - Agriculture	Large-scale poultry operation	Reported and estimated values from the agricultural water users (with focus on farms located near municipal wells)
Non-municipal Domestic (rates below permit requirements)	Domestic water takings	Environment and Climate Change Canada. 2017. Residential Water Use in Canada report.

The future water demand for all water takers, with the exception of the Centre Wellington municipal wells, is assumed to be the same as current water demands. Future municipal pumping rates for Centre Wellington will be estimated in consultation with Township staff. A summary of the water takers within the Study Area was provided in Appendix C of the Physical Characterization Report.

Additional work has been done to estimate demands from non-permitted agricultural water takers located in close proximity to the municipal wells. These water takers were incorporated into the groundwater flow model and those pumping rates will be documented in the forthcoming groundwater flow modelling report.

Water demand associated with potential new developments such as research facilities were not included in this project as those developments have not applied for, or do not hold active permits to take water.

Why is municipal Well F2 included in the study since it's been off-line since 2003?

The Township of Centre Wellington has a Permit to Take Water issued by the MOECC for ongoing water taking from Well F2, even though the well is currently offline. The well was included in the Scoped Tier 3 Assessment because it is a potential municipal water supply well that could be used in the future if treatment were put in place. There are practical reasons why the well is currently not being used; however, the Water Supply Master Plan will assess all wells, including Well F2, in developing long term potential water supply solutions for the Township, and the results of that study may, or may not, recommend that the well be brought back online as a water supply well. The Township wishes to include all potential wells within the Study Area as options, and not close any doors.

How does a PTTW applicant to demonstrate their water taking is sustainable?	The MOECC's Permit to Take Water Manual (2005) sets out what the Ministry considers when evaluating a Permit to Take Water application. Those seeking a permit use the guide to complete their applications and submit any additional required supporting technical documentation. The Manual also sets out the Province's water management policy "to ensure the fair sharing, conservation and sustainable use of the waters…". MOECC ensures this approach is achieved by requiring (as outlined in the Manual) that proposed permit holders must consider the following six principles: 1) the reasonable water needs for natural ecosystem function; 2) prevention of unacceptable interference with existing uses of water; 3) employment of adaptive management to better respond to changing environmental conditions; 4) the cumulative impacts of water takings; 5) the incorporation of risk management principles whereby the level of scientific evaluation required is commensurate with the potential for environmental effects and inference with other users. 6) the promotion public and local agency involvement – municipalities and conservation are notified about long-term, non-agricultural water takings PTTW and provided the opportunity to comment and notices about these applications are posted on the Environmental Registry for the public to review and provide comments.
Does source protection differentiate between takings that returned to the watershed and those that are not?	The purpose of the Source Protection Tier 3 Study is to assess the long-term sustainability of the municipal water sources. From a source protection perspective, consideration is given to the consumptive use of the water taking. Water that is pumped from an aquifer and not returned to the same aquifer is considered consumptive. Consequently, Source Protection studies do not differentiate between takings that withdraw from a groundwater source and return to a surface water source and those that withdraw from a groundwater source and return to a surface water source outside the watershed.
How will the Middlebrook Well be assessed as a part of this study?	The focus of a Tier 3 Study is to evaluate the long-term sustainability of municipal drinking water sources. Future municipal wells evaluated as part of the municipal planning process are included in Tier 3 Studies; however, future water needs of commercial and industrial takers are traditionally not evaluated. As this is a Scoped Tier 3 Study the potential effects of a new non-municipal water taking coming on-line will be evaluated. The proposed taking from the Middlebrook Well has been selected as an example water taking as hydraulic testing data is available from that well, so the results and interpretations can be incorporated into the groundwater flow model. For the Tier 3 Study, the Middlebrook Well will be assessed in a scenario using a rate of 1,637 m^3/day. This rate coincides with the pumped rate during the long-term (30-day) pumping test conducted in 2004 (Gartner Lee 2005). The impact of pumping at this

	rate on water levels in the municipal wells will be evaluated, and the results will be used by the Province and the municipality to guide water management decisions.
Municipal Water Quality	
Will the water budget model be considering water quality in addition to water quantity?	An in depth analysis of water quality parameters is beyond the scope of this Tier 3 Study. How water moves in the subsurface and how water composition changes as it moves are very complex problems to evaluate simultaneously using computer models. Current groundwater modelling practices typically look at water quality and water quantity separately, especially when applied beyond a property level scale. For example, water quantity is assessed through development of a water budget which quantifies the components of the water cycle. In contrast, water quality is evaluated by assessing the geochemical evolution of groundwater along its flow path as it interacts with soil and rock. Developing a groundwater model that integrates water quality and quantity is outside the scope of this project, and the Source Protection program is directed at evaluating water quality and quantity threats separately. However, water quality parameters can provide insight into groundwater movement, and as such are helpful in developing the conceptual understanding of groundwater flow through the subsurface. For example, water quality changes over time within a well can indicate the influence of activities at ground surface and may identify the presence of younger water in areas where older water is expected. The presence of certain water quality parameters can also indicate shorter than expected groundwater travel times. Similarly, information about potentially shortened travel times may provide information about the connectivity of bedrock fractures in that area. Water quality parameters that suggest anthropogenic impacts on groundwater (i.e., chemical contaminants from industrial activity, nitrogen and pathogens from septic systems) or those that are naturally occurring indicators of surface water (i.e., pathogens, atmospheric levels of dissolved oxygen) can indicate connections between surficial sources of contamination and underlying aquifers. For this study, where information about these parameters was available, it was examined as part of the development of the conceptual model and this is why water quality studies are referenced in the Physical Characterization Report. The Township has completed separate water quality related studies to evaluate their municipal water quality and these are summarized and available for review in Section 7.3 of the GRCA's Assessment Report (https://www.sourcewater.ca/en/source-protection-areas/Grand-River-Assessment-Report.aspx).
How is water quality for municipal wells protected?	Ontario's drinking water is protected by a comprehensive safety net that includes the protection of drinking water sources, the establishment and implementation of appropriate treatment and implementation of a comprehensive testing program to verify the effectiveness of treatment. The first step in the safety net approach is protecting the surface or groundwater resources that supply the municipal drinking water systems. This is called Source Protection. The Grand River Source Protection Plan (2015) includes policies to

	address identified water quality threats in Centre Wellington's water quality-related Wellhead Protection Areas (WHPAs) and potential threats and issues identified within the WHPAs are documented in the Grand River Assessment Report (https://www.sourcewater.ca/en/source-protection-areas/Grand-River-Assessment-Report.aspx). A common misconception is that Source Water Protection involves protection of the ultimate recharge area, or "source" of the water within the municipal aquifers. As groundwater flows so slowly, Source Protection studies focus on the 25-year time of travel to reach the well, or the area within which water travels to the well in 25-years or less. This approach ensures municipalities have sufficient time to implement plans to protect the quality and quantity of their surface water or groundwater sources. The Township has established a Risk Management Office in conjunction with the other municipalities within Wellington County. Wellington Source Water Protection's mandate is to implement the *Clean Water Act* for the Wellington County municipalities. Part of this role includes staff who are designated as Risk Management Officials and Inspectors for the Township. Risk Management Officials and Inspectors are responsible for ensuring activities that pose a significant risk to municipal water quality are identified, managed and inspected to reduce or remove the risk. Further information can be found at www.wellingtonwater.ca. Quality WHPAs will be re-evaluated using the groundwater flow model that is being developed as part of this study, and potential threats, such as septic systems and landfills, and issues, such as chloride or TCE, within the new WHPAs will be re-assessed. This work will begin after the groundwater flow model has been developed, calibrated and reviewed by the Provincial Peer Review Team. To learn more about quality-WHPAs and how municipal water quality is protected under the *Clean Water Act*, 2006 please visit: http://www.sourcewater.ca or http://www.wellingtonwater.ca Beyond the *Clean Water Act*, Ontario regulates the quality of drinking water by establishing strict health-based standards for microbiological organisms and chemical and radiological substances, as prescribed under the *Safe Drinking Water Act*. The Ontario Drinking Water Quality Standards are listed in *Ontario Regulation 169/03 (O. Reg.169/03)*. To ensure safe drinking water, the Township's drinking water system operates under a framework referred to as a Quality Management System that was established by the Ontario Ministry of the Environment and Climate Change and legislated under the *Safe Drinking Water Act*, 2002. Treated water samples are collected from the Elora and Fergus water systems on a weekly basis and tested to confirm water quality standards are met. Some parameters, such as chlorine, are monitored continuously. Water quality is summarized in the Township's Annual Water Report. Further information can be found at www.centrewellington.ca.

How do municipalities balance water quality with quantity?	When looking for a new groundwater supply well, municipalities consider the quantity of water available, the quality of the water, and the proximity of the location to existing infrastructure. The ideal municipal water source provides sufficient volumes of good quality water that requires minimal treatment and is located near residents. When such a supply is not available, municipalities must increasingly prioritize water quantity and balance treatment and distribution cost; these are some of the many considerations when a municipality evaluates a new potential groundwater supply well or surface water intake.
Will the Tier 3 Study evaluate private well water quality?	Groundwater is normally clean and safe for consumption. Soils that often overlie groundwater aquifers can act as a natural filter that can slow, or remove certain contaminants. Proper installation and maintenance of private wells should address most water quality concerns; however, treatment is often desired and may even be required. In Ontario, the responsibility for water quality testing and treatment of private wells lies with the private well owners. Through legislation and guidance, the Province aims to protect water quality and its use. The law sets out the minimum rules for: ● Choosing a location for a new well (i.e., setback distances from potential contamination sources such as septic systems, chemicals, etc.); ● Licensing individuals and companies who construct a well; ● Constructing and maintaining a well; ● Abandoning a well (plugging and sealing it); ● Reporting well activities (e.g., completing and submitting well records); and, ● Responsibilities of the well owners. A good reference guide for private well owners was developed by the Grey-Bruce Health Unit: Private Drinking Water. In Wellington County, private well owners that have concerns about their water quality should contact the Wellington-Dufferin-Guelph Public Health Unit. To help ensure water is safe, Public Health Ontario offers free water-quality testing for bacteria. The Health Unit recommends well water is tested for bacteria at least three times a year, with the most important time to test in the spring. Public Health have staff that can help interpret homeowners test results and provide information on disinfection and filtration systems, well upgrades and ongoing well maintenance. Further information can be found at www.wdgpublichealth.ca.

Suggestions to Improve Report Formatting or Readability	Members of the CLG provided several comments regarding the presentation of information in text, figures and maps within the report to help clarify the material presented. These comments were taken into consideration and in many cases the text and figures were updated to help strengthen the document. In some cases, the questions or comments raised will be more fully addressed in subsequent reporting phases of the project (i.e., Groundwater Flow Model Development Report, or the Risk Assessment Report).
Requests for Project Data	Several requests were received for project data related to the Tier 3 Study for independent review and analysis. The purpose of the CLG is to communicate the project to the community as it progresses, and receive local advice and input from the group. The report received by CLG members has been extensively reviewed through a Provincial Peer Review Team consisting of academia and experts in the field of hydrogeology and water resources. It is therefore not the objective of the CLG to provide additional data review. The project database compiled for this study contains data that has been obtained from third party organizations through a data license agreement. As stipulated in that license, the data is for use by the GRCA only for the Tier 3 Study. The GRCA is not permitted to otherwise transfer, sublicense, sell, loan, or disclose the data. Terms and conditions like these are relatively standard when non-open source data is licensed for specific projects between the GRCA and others. The GRCA cannot legally distribute data outside of our data license agreements.

3 Next Steps

The Physical Characterization Report is now final and the groundwater flow model is under development. The model and preliminary results will be assessed by the Provincial Peer Review Team, and presented to CLG members, tentatively in spring 2018. CLG members will be given the opportunity to review and comment on the modelling report and results.

ERRATUM

CENTRE WELLINGTON SCOPED TIER THREE WATER BUDGET ASSESSMENT

PHYSICAL CHARACTERIZATION REPORT

The published report contained the following text (Page 16):

2.4.1.5 Eramosa Formation

The Eramosa Formation consists of three members: the Vinemount Member (lower), Reformatory Quarry Member (middle), and the upper Stone Road Member (Brunton 2008).

The Vinemount Member is approximately 10 m in thickness on average in the Guelph area, but pinches out in the eastern portion of the Study Area. The Vinemount is composed of thinly bedded, fine crystalline dolostone with shaley beds that give off a distinctive petroliferous odour when broken (Brunton 2008). This unit contains mud-rich and microbial mat-bearing lithofacies is dark grey to black in colour, and was commonly mapped in previous studies of the area as the Eramosa Member of the Guelph Formation (Johnson et al. 1992).

The report is updated to contained the following text (changes in bold and underlined):

2.4.1.5 Eramosa Formation

The Eramosa Formation consists of three members: the Vinemount Member (lower), Reformatory Quarry Member (middle), and the upper Stone Road Member (Brunton 2008).

The Vinemount Member is approximately 10 m in thickness on average in the Guelph area, but **is pinched out in the western** portion of the Study Area. The Vinemount is composed of thinly bedded, fine crystalline dolostone with shaley beds that give off a distinctive petroliferous odour when broken (Brunton 2008). This unit contains mud-rich and microbial mat-bearing lithofacies is dark grey to black in colour, and was commonly mapped in previous studies of the area as the Eramosa Member of the Guelph Formation (Johnson et al. 1992).

Centre Wellington Scoped Tier 3 Water Budget and Local Area Risk Assessment Study
Community Liaison Group Meeting #3

Tuesday, May 15, 2018 | 7:00 – 9:30 pm
Aboyne Hall, Wellington County Museum
0536 Wellington County Rd 18, Fergus

Meeting Summary

Welcome

Martin Keller, Lake Erie Region Source Protection Program Manager, Grand River Conservation Authority (GRCA), welcomed Community Liaison Group (CLG) members and thanked them for attending the meeting. He reminded the CLG that the community engagement process they are a part of is an unique approach to engagement during a Tier 3 technical process.

Agenda Review, Introductions and Roles

Ms. Susan Hall introduced herself as the neutral facilitator from Lura Consulting and also welcomed CLG members to the meeting. Ms. Hall reviewed the meeting purpose, roles and responsibilities, and the meeting agenda. She explained that the purpose of the meeting was to provide a refresh of the study process, scope and key participants, provide an overview of the groundwater flow model, receive feedback on the Groundwater Flow Model Development and Calibration Report, provide an update on the Long Term Water Supply Master Plan, and address any questions about the process overall. Ms. Hall welcomed members of the public as observers and led a round of introductions for all CLG meeting attendants.

The meeting agenda is attached as Appendix A, while a list of the CLG and project team attendees is included as Appendix B. The CLG Terms of Reference is available on the project website.

Presentations

Three presentations were given, including an update on the Tier 3 process, an overview of the development of the Groundwater Flow Model, and an update on the Water Supply Master Plan (WSMP).

(1) Context and Process Review

Martin Keller, Lake Erie Region Source Protection Program Manager

Mr. Keller reviewed the context of the Tier 3 project. He identified that the project is now in its third stage, groundwater flow model development and calibration. Mr. Keller reviewed both the CLG input and peer review feedback cycle to highlight how input has been incorporated into the Tier 3 process. Mr. Keller reviewed the regulatory processes connected to Tier 3 studies, and provided a linkages map to highlight the connections between the Tier 3 and the WSMP process.

(2) Groundwater Flow Modeling Overview

Patricia Meyer, Senior Hydrogeologist, Matrix Solutions Inc.

Ms. Meyer described the model structure, linkages to the physical characterization report, the process of model calibration, and model application. Ms. Meyer began by reviewing the purpose of the model and the inputs into the model, including the data provided by CLG members (i.e.: Water level data provided by Highland Pines/Pine Valley and Nestle Waters Canada and domestic water demand estimates by Save Our Water). She explained that the model is a 3D numeric model, developed to include over 3 million elements. The purpose is to provide insight into where and how much groundwater is flowing through different aquifers. She noted that calibration included over 400 runs to calibrate the model as closely as possible to actual water level data. Water level data was integrated from 48 monitoring points and over 4,100 domestic wells. All available data was used during calibration. Overall, the consultant team and the provincial peer reviewers are confident in the validity of the model and the calibration process.

Ms. Meyer also provided an explanation of the water budget within the study site. Approximately 98% of water entering the system does so through recharge (e.g. precipitation). Approximately 1% of water entering the study area enters through horizontal (i.e., lateral) flow in overburden and upper bedrock aquifers, and another 1% enters through horizontal (i.e., lateral) flow within the lower bedrock aquifer. Permitted pumping captures 4% of the water flow through the study area; the majority of groundwater flow through the area (88%) sustains baseflow to surface water features (i.e., streams / rivers / lakes / wetlands), while the remaining 8% flows to down-gradient regions as groundwater.

Ms. Meyer provided a list of uses for the model, including:

- Evaluating change in water levels due to new water wells
- Evaluating change in water levels due to new land development
- Evaluating change in groundwater flow into rivers and streams due to increase/decrease in pumping rates, etc.

Ms. Meyer explained that the next steps for the model are to work with the project team, Township and AECOM to refine the model, and to understand the range of potential model results as they relate to risk assessment, climate change scenarios, and the Water Supply Master Plan. Ms. Meyer highlighted

that the model is part of an iterative review process and will be updated as new information comes available in the future.

(3) Centre Wellington Water Supply Master Plan (WSMP)
Patricia Quackenbush, AECOM and Matthew Alexander, AECOM

Ms. Quackenbush and Mr. Alexander began by providing a process overview of the WSMP and explaining how the WSMP follows the Municipal Class Environmental Assessment process. She outlined that the Township is planning for the anticipated growth in Centre Wellington to 2041, to ensure the provision of safe and reliable water to all residential, industrial, commercial and institutional customers in urban areas. This requires the WSMP to identify and evaluate alternatives for meeting projected water supply needs (including water conservation and demand management), and develop preferred long-term solutions for meeting water needs. Currently, the WSMP is in Phase 2 of the Class EA process, where water supply alternatives are being developed. The WSMP has completed a draft preliminary assessment of existing water supply capacity, projected average and maximum daily demands to 2041, and estimated water surplus and deficit over time (based on current supply capacity and projected demand).

Ms. Quackenbush and Mr. Alexander explained that model outputs will inform the WSMP about available groundwater capacity to meet future demands and potential locations for future supply wells to minimize potential impacts to the municipal supply system, natural environment, and social environment. The groundwater model will also provide direction to future groundwater exploration programs and proposed Class EA undertakings.

Ms. Quackenbush outlined WSMP next steps and provided a timeline for future public engagement consultation opportunities.

A combined copy of all three presentations is available on the project website.

Facilitated Discussion

Questions of Clarification

A summary of the questions of clarification is provided below. Questions are noted with **Q**, responses are noted by **A**, and comments are noted by **C**. Responses with text in italics include further clarification provided by the project team after the meeting. Please note this is not a verbatim summary.

Facilitated Discussion #1 – Groundwater Flow Model

CLG members were given the opportunity to ask questions and share comments or concerns relating to the model (or report).

Q. Regarding accuracy, the terms "good", "reasonable", "suitably well" etc. are used to address situations that contain uncertainty and data gaps through the report. On a scale of 1 to 5 what is the goodness of fit rating?

A. The model replicates the data well, but your point is taken that throughout the report, "very good" and "reasonable" are used. These words were used to convey that we feel confident about the data and the report. Regarding certainty around calibration, once you can replicate water levels through the domain (*model*) it brings good confidence that you can represent how water is moving through the groundwater system. This builds overall confidence in using the model moving forward. Additionally, the 6-week pumping test is a very good indicator that the model is reliable. Provincial peer reviewers also look at calibration of the model and they agreed with and support Matrix's work.

C. You've done different Tier 3 studies, and each has different data available, so my question is more about the uncertainty.

A. We are always interpreting what is happening between available subsurface monitoring points. The points tell us what the general material in between those two points needs to be. This lets us understand how water flows through the system. The 6-week pumping test provides very valuable data that gives us confidence in model parameters. That pumping data, which systematically stresses the aquifer system, is not available for all other municipal systems where we have completed Tier 3 studies, but it is very valuable to understanding groundwater parameters for this Tier 3 study. Consequently, the uncertainty in this Tier 3 study is not greater than in other Tier 3 studies.

Q. The test is 3 days on 3 days off, in different areas throughout the modeled zone, including Elora?

A. Yes, we wanted to capture the data all at once. We didn't want to just look at Fergus, or just Elora, we wanted to take a holistic approach.

Q. How accurate is that data to extrapolate to 365 days?

A. We have long-term and short-term data available. We have well data that records water level data that reflects long-term pumping of the municipal wells; this gives us the long-term data. The short-term data comes from the 6-week pumping test; it allows for a refinement of the regional features of the model in the vicinity of the municipal pumping wells.

Q. For Table 5, the Middlebrook Well, when looking at comparisons between estimated observed drawdown and simulated drawdown, does "during" mean at the end or the beginning of the test? When was the drawdown?

A. At the end. That was the greatest drawdown before the recovery.

Q. Is well DDH5 an Ontario Geological Survey (OGS) well, and was it looked at?

A. The data was requested from that well as recently as 3 weeks ago, however it is still unavailable. The OGS was collecting water levels at several points along the well, however this data is being collected outside of traditional methods, which is leading to the delay in data processing.

Q. Can we plug in this data to the model once we get it?

A. The ease of incorporating that data into the model depends on the data we are provided. Our focus was on the municipal wells for calibration. We would treat OGS data as verification data and ensure things aren't dramatically different than what we've modeled.

Q. Are there any indications that the Gasport Formation thins as it approaches Fergus?
A. We would have to look at the data and get back to you. Thinness throughout the model was determined by the high-quality data we have. It is important to note that there are also some oil and gas wells by Belwood Reservoir, and some north of Grand Valley. All the points to constrain the thickness of Gasport are cited in the report, but I can look for the thickness and get back to you.
[Post meeting response: After reviewing the data, the Gasport Formation does not thin as it approaches Fergus. Based on borehole information, it is locally thicker in the Fergus area, ranging from approximately 14 m to 22 m in thickness.]

Q. Were you able to meet with the group at the University of Guelph doing research relevant to the Tier 3? Did they share data with you?
A. We did meet with the G360 group, and they have shared their data with us. We discussed the bedrock valley location and their findings are consistent with the information we have. The work they have completed in the past resulted in municipal monitoring wells (i.e., multi-level wells); that data is already included in our calibration data set. G360 are also undertaking a geological survey using electromagnetic waves to measure various levels of sediment. From what we saw of that information, it is consistent with the interpretation we have.

Q. In the Report, it states that baseflow estimates are measured at Irvine Creek. What was the input from that particular estimate? How important was the estimate from that baseflow?
A: Baseflow refers to the groundwater contribution to a stream that sustains it during dry periods. This varies throughout the year. There is a GRCA gauge on the creek, and it monitors the water level. Stream flow is estimated from the water level data, that is a continuous estimate. To get the baseflow, hydrograph separation techniques are used to estimate how much is contributed from stormwater or overland flow and how much was contributed from groundwater.

Q. Would the test be run at more than just the Irvine site? What happens if you get zero reading at Irvine Creek? Sometimes there is no water flowing through that gauge.
A: We wouldn't get zero reading as there is constantly a groundwater flow, even if the recharge is low. More gauges were put in place during the Tier 2 study. Irvine Creek is used as a calibration point.

Q. You use the baseline from Irvine Creek throughout the model, but if that flow is exceptionally low, then if that data is extrapolated, is it a reasonable measure to use? Would other areas have higher baseflow?
A. The baseflow at Irvine Creek is representative of the geography. While this is the only baseflow calibration point within the flow model, it reflects the low amount of recharge in this part of the study area, which is the primary recharge area that provides flow beneath Fergus and Elora. The recharge we

applied comes from the Tier 2 study, which was calibrated to many more gauges, not just confined to that one gauge.

Q. This report states that the upper Guelph Formation is an important barrier. Karstic rock covers much of the surface around the upper Guelph Formation. I am concerned that there are many cracks and fissures, and that this area may not be as competent as described. Is there a tight aquitard in the upper Guelph Formation? Is that a change in characterization from one report to the other?
A. When there is an interface from overburden to bedrock, there are often very fractured areas of weathered bedrock present; that is how water in the area finds its way into the Grand River. The difference between the heads in the shallow and lower bedrock (i.e., across the Guelph Goat Island Formations), is about 20-25m, with the majority of that head-change occurring across the upper portion of the Guelph Formation (as evident from the available multi-level data). We know in Shelburne and in Cambridge, similar lower hydraulic conductivity conditions are also present in the Guelph Formation. Combining that data and using multi-well data, we can identify that in the upper Guelph unit, and throughout the region, there is a tight aquitard. While this makes it harder for water to get though, water still does eventually infiltrate, just at a slower rate. There is a well drilled in the south, as part of Guelph Tier 3 study, showing 6 metres of head loss. This may be a reflection of how the different layers thicken and thin.

Q. What plans are in place to update the model in the future (e.g. 5-10 years)?
A. The model will be updated as there is an appropriate need, or new information comes available. Within the Source Protection Program, for example, when there is a planned update for the Grand River Source Protection Plan, we will look at what technical studies need to be done to update the plan, and those studies may lead to an update of the model. Similarly, for the Township's Permit to Take Water, they are required to input new data into the model; this could also lead to an update of the model. Additionally, there may be other interrelated processes at various levels of government for various agencies that may require use of the model; this is another route which could lead to an update of the model. We will need to evaluate what new information is available when the model is next used, and identify if new information fits in with the existing model, or if the model requires revision.

C. The concern is these are living models, but the permits and other allowances based off this model are permanent.
A. When a municipal class environmental assessment is completed, or a new Permit to Take Water is issued, that information can go into and inform the model. All sources of information act as a series of cogs that move simultaneously and interrelate to inform our understanding of the larger water system. For example, quality-related Wellhead Protection Areas will be updated using the Tier 3 groundwater flow model. The province also has a re-evaluation plan for Source Protection Plans with set dates, which required gaps in the Plans be identified. This may also influence the model.

Facilitated Discussion #2 – Moving the Process Forward

CLG members were given the opportunity to ask questions relating to the process moving forward.

Q. Within the Report, it states the model is based on a scoped Tier 3, and that therefore, some scenarios cannot be run through the model at this time. This includes some risk scenarios that must be run at a later date. What are the scenarios that cannot be run?

A. The Tier 3 is scoped as the project team does not have all of the information needed from the WSMP to run all the scenarios required for the risk assessment. For example, we do not have all the information from the WSMP about future pumping rates; as this information comes available we will be able to evaluate the risk assessment scenarios which require information related to future water demand.

Q. We also don't know the prescribed density after 2031; is that another uncertainty?

A. The prescribed density is not tied to the year 2031. There is presently a minimum greenfield density target of 40 people and jobs per hectare, as wells as a target for 20% of all new residential dwellings to come within the built boundary (ie. through intensification). This target has been assumed to be in effect for all of the land in the urban centre, for the purposes of the Tier 3 study and the Water Supply Master Plan. The 2017 Growth Plan revises the targets to a possible 80 people and jobs per hectare, and 60% of residential dwellings coming from intensification. But the County can request a lower target through its Official Plan review exercise to conform to the Growth Plan. This has to be done by 2022. In the meantime the current targets (40 people and jobs per hectare and 20% intensification) remain in place and new developments are being planned at that level.

For the Tier 3 study, density is related to the growth footprint. If the growth footprint is smaller because of increased density, this will result in less overall impervious area and therefore less impact to the quantity of recharge entering the groundwater system.

Q. So will you be able to run the growth part of the model that addresses impervious areas past 2031, or will it have to stop there?

A. This is why the project is a scoped Tier 3. Usually future development is evaluated based on growth projections contained within the Official Plan. However, for this project, until we have the preferred solution from the WSMP, future supply requirements are not known. We will need those decisions from the WSMP in order to assess a number of scenarios that are a part of the risk assessment.

Q. The report outlines 155 liters of demand in Fergus, per person, per day. Is that correct?

A. The billing meter data is in the range of about 155-165 litres per capita day, based on residential demand.

Q. How critical is that to what you're doing?

A. Although we are adopting a more conservative approach for estimating future water supply needs by projecting demand based on historical total well production (supply) information, a review of residential

metered data is useful to assess water conservation/ demand management as an alternative. For example, where residential water use is already low, there may be limited opportunities to implement additional water conservation measures.

Q. What happens if the figure is inaccurate or too low?
A. For the WSMP, we are using production data from the wells which captures all consumption and water losses in the system in our future water supply projections. It provides a more conservative estimate and reflects the potential for system loss in the form of leaks, additional demands aside from residential, and the concern around using meter data (as hard water may impact the reliability of the meters).

Q. For the climate change risk assessment you are looking at precipitation and temperature, but are you looking at more than those two factors (e.g. the amount of intense rain events)?
A. We look at global circulation models (GCMs) to provide insight on how the climate may change. Along with temperature change, they predict change in precipitation intensity and when and where precipitation will occur. Those models inform how we think groundwater recharge will change. The groundwater recharge piece is what is used as input to the groundwater model. Of the multiple GCM predictions of temperature and precipitation changes available we plan to run about 10. This gives us an idea of the potential variability under climate change that we should expect. We can use that knowledge to understand how climate change may impact the reliability of water levels in municipal wells. Centre Wellington municipal wells are deep, and to a degree, isolated from surface changes. There will be value in seeing how long it takes climate changes at the surface level to impact groundwater levels at these depths. That is what we want the model to help us understand.

Reflection and Next Steps

Mr. Keller provided reflections on the CLG process so far. He highlighted the data contributions from CLG members including the provision of water taking monitoring data, well records, and water demand data from domestic wells. He also highlighted the use of the CLG as a vehicle to provide information to broader groups of stakeholders, as a forum for discussion and question and answer sessions, and to explain the peer review process and share comments.

Mr. Keller confirmed with CLG members that they should provide any additional comments or questions regarding the Groundwater Flow Model and Report by June 5th, 2018. He explained that these comments will be summarized and posted on the project website. Mr. Keller stated that presentations from the meeting will be posted on the project website. Mr. Keller explained that the next steps include the project team beginning the Risk Assessment, documenting results, circulating the results for provincial peer review of the results, updating the results to reflect peer review comments and then sharing the results of the Risk Assessment at the next CLG meeting. The date for the next CLG meeting is to be determined.

Ms. Hall thanked CLG members for contributing to the discussion and adjourned the meeting.

Appendix A – Agenda

Centre Wellington Scoped Tier 3 Water Budget
and Local Area Risk Assessment Study

Community Liaison Group Meeting #3
Tuesday, May 15, 2018
7:00 – 9:30 pm
Boyne Hall, Wellington County Museum

***Meeting Purpose**:*

1) Provide a refresh of the study process, scope and key participants;
2) Provide an overview of the groundwater flow model;
3) Receive feedback on the Groundwater Flow Model Development and Calibration Report;
4) Provide an update on the Township of Wellington Long-term Water Supply Master Plan; and
5) Address any questions about the process overall.

AGENDA

7:00 pm	**Welcome** Martin Keller, Lake Erie Region Source Protection Region Program Manager
7:05 pm	**Agenda Review, Introductions and Roles** Susan Hall, Facilitator, Lura Consulting
7:15 pm	**Context and Process Review** Martin Keller, Lake Erie Region Source Protection Region Program Manager
7:30 pm	**Groundwater Flow Model Overview** Patty Myer and Paul Martin, Matrix Solutions Inc.
8:00 pm	**Small Group Discussion Session 1 – Groundwater Flow Model** • ***What questions, comments or concerns do you have relating to the model (or report)?***
8:30 pm	**Township of Wellington Long-term Water Supply Master Plan** Patty Quackenbush, AECOM
8:45 pm	**Process Moving Forward** Martin Keller, Lake Erie Region Source Protection Region Program Manager
9:00 pm	**Small Group Discussion Session 2 – Groundwater Flow Model** • ***What questions do you have relating to the process going forward?***
9:25 pm	**Wrap up and Next CLG Meeting** Susan Hall and Martin Keller
9:30 pm	**Adjourn**

Appendix B – List of Attendees

A. Community Liaison Group Members

Member	Organization
Andreanne Simard	Nestlé Waters Canada
Dave Blacklock	Wellington Water Watchers
Derek Graham	Chamber of Commerce
Jan Beveridge	Save Our Water

B. Project Team Members

Core Team	Support Team	Organization
Martin Keller Sonja Strynatka	Emily Hayman	Grand River Conservation Authority
Patricia Meyer	Jeff Melchin Paul Martin Christian Gabriel	Matrix Solutions Inc.
Kyle Davis	Emily Vandermeulen	Wellington Source Water Protection
Colin Baker		Township of Centre Wellington
Susan Hall	Alex Lavasidis	Lura Consulting
Patricia Quackenbush	Matthew Alexander	AECOM
Kathryn Baker		Ministry of Environment and Climate Change

In addition to the participants listed above, 8 observers were in attendance at the meeting including members of the public and Lake Erie Source Protection Committee member for the area.

DRINKING WATER SOURCE PROTECTION
Our Actions Matter

LAKE ERIE SOURCE PROTECTION REGION

Centre Wellington Scoped Tier 3 Water Budget Study: Discussion on draft Groundwater Flow Model Development and Calibration Report

Location: Grand River Conservation Authority Head Office, Cambridge
Date: August 13, 2018
Time: 1:30 pm to 3:30 pm

Meeting Objective: To discuss and provide clarification to comments provided by S.S. Papadopulos & Associates on behalf of Nestlé Waters Canada (NWC) on the draft Groundwater Model Development and Calibration Report prepared as a part of the Centre Wellington Scoped Tier 3 Water Budget Study.

Discussion Items: A list of discussion items are included in the meeting agenda in Appendix A.

Participants: A list of participants is available in Appendix B.

Comments: Comments provided by S.S. Papadopulos & Associates on behalf of NWC are provided in Appendix C.

Summary
Project consultants discussed NWC's comments with the group; the discussion has been summarized into the follow sections:

- Model domain and boundary conditions
- Model calibration
- Data gaps and uncertainty assessment
- Water budget
- Middlebrook well
- Model purpose

Model Domain and Boundary Conditions
Matrix provided an overview as to:

- How the current groundwater flow model was expanded beyond the previous boundaries of the Golder groundwater model,
- The development of the three water level contour maps for the study area (overburden; contact zone and Upper Guelph Formation; Lower Guelph, Goat Island and Gasport Formations),
- How boundary conditions were set for each of these layers in the 3D model.

There was further discussion with the OGS regarding the lower Guelph Formation's characterization as an aquitard [to the north] and how this is supported by available data.

SSPA inquired about the boundary conditions around the outside of the model and if surface water boundary conditions are fixed and controlled by the DEM. Matrix described how the boundary conditions for each of the aquifers were derived from available water well records and confirmed that surface water boundaries are fixed and based on the hydraulically corrected DEM.

Matrix further reviewed model recharge as another boundary condition. SSPA noted that the important questions to answer with the model overall are: where does the water come from and where does the water go? OGS suggested providing figures for the various interpreted flow zones that show the key wells used to inform the model with regard to water levels, hydrostratigraphic characterization, and flow directions across model boundaries. SSPA is interested in how the model fits into the sub-watershed budgets from the Tier 2 analysis. The discussion following expanded upon the comparison of the Tier 2 and Tier 3 water budgets presented in the draft Groundwater Flow Model Development and Calibration report.

Matrix reviewed how the model fits into the sub watershed budgets from the Tier 2 analysis by reviewing Table 8 of the report. The conceptual model and information available has evolved significantly from the Tier 2 water budget study. Previously, consultants were using an older configuration of Guelph-Eramosa bedrock units, which is different from those that have been characterized more recently.

Matrix also noted that none of the previous Tier 3 models followed Tier 2 boundaries; this same process was followed in the City of Guelph / Guelph Eramosa Township Tier 3 study. Most of the data for Tier 3 studies is concentrated around municipal wells.

MECP suggested that a limitation of the Golder Report in completing the water capacity assessment was data availability, and questioned why this did not remain a limitation in the current Tier 3 study when the domain is larger than in the Golder Report. Matrix responded that the size of the Golder model was a concern, and not the data available. With extensive capture zones, many wellhead protection areas in Ontario bedrock aquifers extend well beyond the municipal data available.

MECP requested Matrix to document areas where data availability is limiting, and how things may change in the future, and how to use/interpret the existing information. Matrix replied that beyond the data gaps already discussed within the draft Groundwater Flow Model Development and Calibration report, they will be better able to identify areas where additional data is needed once the uncertainty analysis and risk assessment is completed. This will tell them which areas of uncertainty most-affect the municipal wells.

Model Calibration

Matrix provided a discussion on their approach to model calibration. There are fairly uniform hydraulic conductivities throughout the study area. The Guelph Formation acts as an aquitard. SSPA inquired where the aquitard in the Guelph Formation is located. Matrix explained that the Guelph Formation aquitard is represented as fairly ubiquitous through the model, upgradient of the municipal wells.

Matrix provided further discussion on their approach to steady state calibration. SSPA requested two versions for the steady state model calibration chart, one with the high-quality data and one with the low-quality data.

Matrix noted that water well records may carry 5-10 m average uncertainty. That is essentially the most accuracy a model can attain, as that is the average variability of groundwater level observations over an area. SSPA inquired about the probability distribution of the calibration residuals. Matrix discussed with the group the general challenge of calibrating to municipal wells because water levels change hourly and can vary by > 30m within a day depending on pumping demand. Further discussion ensued regarding how they are addressing these challenges.

MECP inquired if observation wells (located near to municipal wells) can provide data that is a better fit for the model. Matrix responded that observation wells can provide tighter ranges on data. They stated that there were challenges matching both the overburden and the bedrock sets. Some clusters of observation wells are multilevel well systems with large water level changes (e.g., 20-25m) over relatively short vertical elevation differences (e.g., 5m).

SSPA commented that pumping well data is not a reflection of the variability of the water levels, but rather of the variability of the pumping and non-pumping conditions. SSPA suggested that water levels recorded for older private water well records could reflect conditions that pre-date pumping, and further suggested filtering these data sets to ensure the model calibration focuses on data that reflects stressed conditions. SSPA noted that E4 has very wide ranges, which can be ascribed to the difference between pumping and non-pumping.

MECP stated that if there appears to be a large head difference between the overburden and the bedrock, then water is moving through. Matrix responded that the multi-level well data, and the gradients they indicate, are key data for calibrating the hydraulic conductivity of the Guelph Formation bedrock aquitard. The calibrated water levels are very sensitive to the hydraulic conductivity of the aquitard. Within the Fergus and Elora Area, Matrix has a relatively high level of confidence in the hydraulic conductivity.

SSPA inquired if there was accounting for well losses. Matrix responded that well losses for existing pumping conditions were accounted for in the model calibration. Through the transient calibration efforts, well responses to pumping were directly incorporated into the model, as demonstrated by the ability to match the long-term pumping and shut-down data collected during Fall, 2012. Additional well losses are added manually when evaluating potential responses to future pumping, beyond rates experienced during tested in 2012.

OGS inquired if the E3 and E4 pumping tests were fairly reliable. Matrix responded that they were, and that the model-simulated and observed values match very well. Matrix responded that the drawdown data sets are unique for each well and that local hydraulic conductivities are independently assigned. There is a good match in both locations between the observed and simulated responses to pumping as documented in the calibration report. The response to pumping is simulated to propagate across the Guelph Formation aquitard. Simulated responses across the aquitard are a good match to those observed at key multi-level wells (report Figure 13a-d), but was less than observed in MW1 and MW4. Throughout the bedrock system there were good matches in response to timing and magnitude between the model simulation and observed data. This includes the Middlebrook well, where the model adequately reflects observed pumping-response data. Although not perfect, the magnitude is a decent match, which gives a sense the model is simulating the propagation of hydraulic head changes between those locations reasonably well.

SSPA inquired if everything apart from the pumping is held constant. Matrix responded that everything else is held constant. Achieving the steady state and transient calibrations provides confidence moving forward with the water quantity risk assessment.

SSPA inquired if there was a good match around the Guelph Formation, and if the hydraulic conductivities are similar to what Golder inferred in their analysis. Matrix responded that they started working with the Golder characterization of hydraulic conductivity (zones of uniform hydraulic conductivity) and adjusted them to ensure observed water levels were matched as well as possible. The absolute values were different, but similar.

Matrix also noted that they had a reasonable match to simulated groundwater discharge in Irvine Creek, based on the best available information. SSPA noted this is the only stream monitoring station not affected by a reservoir.

SSPA inquired how much variability was observed and simulated at the Middlebrook well during the 2012 pumping test, as illustrated in Figure 13d of the groundwater modelling report. Matrix replied there were about 2 m of variability.

Matrix responded to SSPA's inquiry about the degree of scatter present in Figure 11 of the draft Groundwater Model Development and Calibration Report. The scatter shown in Figure 11 reflects:

- The transient nature of the water level measurement, and whether it is actually contiguous with the pumping conditions or not.
- Structural error and measurement error. For structural error, a water level is being associated with a specific hydrostratigraphic unit within the bedrock; the accuracy of that association depends on the local fractures and where those local fractures are intercepted by that well.
- The assumption is that the water level in the well is representative of the deepest unit the well extends into.

MECP inquired how timing fits into that the selection of the calibration dataset: how data may be from the 1980s and 1990s, and some are from today, and then combined. Matrix responded that is one reason why they expect it to be scattered.

MECP noted that if the same spots are measured today, those same points may be different. Matrix highlighted that the Provincial Groundwater Monitoring Network (PGMN) data don't change a lot over time, reflecting that we should expect background water levels to be relatively consistent outside the influence of pumping.

MECP suggested a clearer qualifying statement be included and highlighted that private well data are not all high quality. Matrix responded that the bigger issue is the location of older data (as measurements of location in past decades are less certain); but the decision to include that data is based on the idea that it is better to have more data than less.

Matrix noted that on the baseflow data, the Irvine River has a drainage area of 195 km^2. They don't have better information on other streams, but the up-gradient area is what is most important from an impact perspective. SSPA replied that they thought down-gradient areas would be more important because pumped water would otherwise discharge further downstream, so with respect to sustainable yield it is how much toleration there can be for a reduction in base flow. Matrix responded that the effect of municipal pumping is small relative to flow in the Grand River and as such pumping effects are unlikely to be evident on the Grand River, but would be evident further downgradient in smaller streams. SSPA suggested identifying where the consulting team would want stream gauges located, to improve stream flow monitoring through time.

Data Gaps and Uncertainty Assessment

In response to SSPA's concern about addressing data gaps and the uncertainty approach, Matrix noted that a Null Space Monte Carlo (NSMC) assessment is planned and will employ PEST (a model-independent parameter estimation and uncertainty analysis tool). This is a substantial process and will be executed once Matrix is confident that no further changes to the model are required.

Regarding concerns about ensuring sufficient high-quality monitoring targets, Matrix responded that high quality monitoring wells are mostly focused around pumping well locations. This is typical of most municipal systems, including those where a Tier 3 analysis has been completed. SSPA further inquired about high quality monitoring targets, and if there are as many as in most other comparable studies, including any PGMN wells. Matrix noted that there is a gap in high quality data between Fergus and Arthur, and this recommendation will be included in the report.

Water Budget

Matrix provided an overview of the water budget and groundwater movement within the Tier 3 study area.

Regarding SSPA's concerns about the majority of water staying shallow and supplying local streams, Matrix noted that this is consistent with their analysis and understanding of most Ontario groundwater systems. Low topographic relief results in low energy (i.e., driving force) that would yield large regional groundwater flow. Pumping is approximately 4% of total inflow.

Kast Subdiscussion

OGS provided discussion on the groundwater flow through the karst system within the study area. They assert that this was not adequately integrated into the model. Matrix stated they haven't seen the hydraulic data to support those solution cavities extending over large distances. The Equivalent Porous Media (EPM) approach that is being used for this model assumes there are interconnections of fractures and open zones that happen throughout. If there was one strong interconnection, it would be evident in the pumping data.

OGS referenced numerous reports from Florida where attempts have been made to map karst conduits. Researchers have had similar challenges as in Ontario when trying to model karstic system. There needs to be a discussion about the Fergus and Elora flow system regarding the fact that a lot of the water entering the wells comes from very specific horizons (not uniformly throughout a given formation). Discussion ensued with the OGS regarding the connectivity of the karst conduit system.

SSPA requested a figure showing cross boundary flow arrows with attached values.

SSPA inquired if the 6% of the water budget noted as leakage/recharge would impact or place a limit on how much water can be pumped, or if pumping would induce more leakage. Matrix responded that more pumping would induce more leakage. SSPA noted that it would be wrong to read the water budget figure and state that 6% is the maximum that users can take from the system, as that would be an incorrect analysis of the situation.

SSPA inquired if the model conserves flow at the scale of the new areas. Matrix noted that the water budget values are directly from the model simulations without adjustment and reflect that the model conserves flow.

SSPA suggested that Matrix show what the rainfall and evapotranspiration numbers are for the water budget. Matrix noted that this would probably show that the shallow flow that occurs is fairly local, and not all of it is going through long groundwater flow paths.

Middlebrook Well

Matrix noted that the Middlebrook well is not simulated as a well or an open conduit. Matrix provided an overview of how the model was calibrated to observations at the Middlebrook well, and responded to SSPA's concerns about over-simulation of drawdown at the Middlebrook well. Matrix hypothesized that including a strong karstic zone at depth would reduce the simulated drawdown at the Middlebrook well, but that is not yet implemented in the model.

MECP noted it is important for the report to be clear about what data gaps are present and what next steps should occur to strengthen the model, and where the model needs refinement.
Matrix responded that the data gaps discussion in the calibration report and future recommendations will remain focused on what the municipality needs to do to evaluate their water quantity risk assessment. GRCA noted that instead of making recommendations on the aforementioned topics, the consultants could make a statement that outlines what the boundaries are in which the consultants completed this project, and provide recommendations within. This could be a statement about what the appropriate use of the model is and is not, in its current state.

The Township of Centre Wellington noted that the model will inform where they place new wells to keep up with growing water demands.

Matrix noted that as wells are drilled, and additional long and short-term pumping tests are completed, those data sets will provide additional data that can be used to continuously improve the model.

MECP inquired if the water budget percentages reflect maximum or average pumping. Matrix responded that the current water budget numbers reflects 2016 pumping, not maximum pumping. MECP requested that water budget percentages also be reported under high pumping conditions. Matrix stated that was possible and reminded the group that those numbers will change based on the demand on different parts in the strata.

SSPA asked whether the simulated transmissivity in the model local to the Middlebrook well reflected that estimated through pumping tests (i.e., 300 m^2/d). Matrix provided data that indicated that the simulated transmissivity of the Gasport layer alone was 75 m^2/d, but that they did not have information for the simulated cumulative transmissivity along the entire length of the Middlebrook well; such detailed assessment of the Middlebrook well is considered outside the scope of the Tier 3 study.

Model Purpose

Matrix discussed that they do not dispute the existence of karst zones; their understanding will evolve through time and new information, as it becomes available, should be used to refine the model to that it can continue to be a useful tool for understanding and managing local water resources. Generally, the model is a reasonable representation of the system.
Matrix further summarized the stated purpose of the model:

- To simulate the ability for municipal wells to meet future / allocated rates under steady state and drought conditions;
- To assess the impact of changes in pumping and land use development on municipal wells and other water uses, such as cold-water streams and Provincially Significant Wetlands.

The model is well-calibrated to both steady-state and transient responses in multiple aquifers. The model has also met the standard of other Tier Three assessments and has been reviewed by a team of provincially appointed expert peer reviewers.

The current state of the model calibration is suitable for the scoped Tier 3 water quantity risk assessment. It can be considered a “living” tool that can be updated as new data / knowledge becomes available to meet needs outside of the Tier Three assessment. Centre Wellington maintains an active groundwater monitoring network and will continue to build system knowledge.

OGS requested additional information be provided to show what wells are used to make various statements. They questioned how any groundwater flow can be modelled in the Gasport as there are very few wells in that area. Matrix responded that they have implemented the best available conceptualization, and applied hydraulic conductivities that are similar to those applied in neighbouring studies to simulate conditions in the deep bedrock, even though the observation data for these units is lacking.

SSPA noted that it is important to qualify that the model’s best fit is in the immediate vicinity to municipal wells where there is high quality data. SSPA noted that the Irvine Creek data used to calibrate groundwater – surface water interaction only constrains conditions upgradient of the municipal wells, not down-gradient of the municipal wells, where pumping impacts are most-likely to be observed. As such, SSPA stated that in their opinion, the model will not be able to reliably answer the question of how increased municipal pumping will impact surface water features downgradient.

Meeting Outcomes

The following list details how the draft Groundwater Model Development and Calibration Report will be updated based on the discussion provided in the meeting summary below.

- Additional documentation will be provided to support the selection of boundary conditions. A table will be generated within the Risk Assessment report with

boundary condition values and the range of uncertainty given the potentiometric surface and the number of points used to interpolate values.

- A work plan will be developed by Matrix to complete the following:
    - Three to four model scenarios to test the sensitivity of the model calibration and water balance to changes in boundary condition values. Results will be documented in the Risk Assessment.
    - A karst assessment through the creation of a 3D conceptual model of a karst feature. PEST optimization will be completed to evaluate the hydraulic conductivity of the proposed karst feature. Simulated flow conditions with the calibrated karst feature will be reviewed to document new insights gained. Results will be documented in the Risk Assessment report.

- The draft Groundwater Model Calibration report will be updated with the following:
    - a figure showing cross-boundary groundwater flows
    - independent steady state calibration scatterplots for high-quality data and low-quality data. a cumulative probability distribution plot of residuals

Next Steps

The GRCA will publish a summary of the meeting to the project web page. Matrix will finalize the groundwater model development and calibration report and move onto completing the uncertainty and risk assessment.

Appendix A – Agenda

Centre Wellington Scoped Tier 3 Water Budget Study: Discussion on draft Groundwater Flow Model Development and Calibration Report

Location: Grand River Conservation Authority Head Office, Cambridge
Date: August 13, 2018
Time: 1:30pm to 3:30pm

Invited Participants:

Grand River Conservation Authority	Ministry of Environment, Conservation, and Parks
Ontario Geological Survey	Nestlé Waters Canada
Lura Consulting	Township of Centre Wellington
S.S. Papadopulos & Associates	Wellington Source Water Protection
Matrix Solutions Inc.	Aqua Insight

Meeting Objective: To review and discuss comments provided by Nestle Waters Canada on the draft Groundwater Flow Model Development and Calibration Report.

Agenda:

- Selection of model domain and boundary conditions
- Water budget
- Data gaps and uncertainty assessment
- Model calibration
- The use of the model to evaluate potential reductions in groundwater discharge to surface water features
- Middlebrook well

Appendix B: List of Participants

Aqua Insight
- Paul Martin

Grand River Conservation Authority (GRCA)
- Martin Keller
- Sonja Strynatka

Lura Consulting
- Alex Lavasidis

Matrix Solutions Incorporated
- Christian Gabriel
- David Van Vliet

Ministry of Environment, Conservation and Parks (MECP)
- Abdul Quyum
- Kathryn Baker

Nestle Waters Canada (NWC)
- Andreanne Simard
-

Ontario Geological Survey (OGS)
- Frank Brunton

SS Papadopulos (SSPA)
- Chris Neville

Township of Centre Wellington
- Colin Baker

Wellington Source Protection
- Emily Vandermeulen
- Kyle Davis

Appendix C: Comments provided by S.S. Papadopulos on behalf of Nestle Waters Canada

Dr. Andreanne Simard, Ph.D.
Natural Resources Manager
Nestlé Waters Canada
101 Brock Road S.
Puslinch, Ontario
N0B 2J0

Subject: Centre Wellington Scoped Tier Three Water Budget Assessment

Review comments on the draft Groundwater Flow Model Development and Calibration Report

Dear Dr. Simard:

In this letter we provide comments on the **Centre Wellington Scoped Tier Three Water Budget Assessment: Groundwater Flow Model Development and Calibration Report** (*2018_05_08_draft-groundwater-model-development_calibration-report.pdf*). The draft report is dated May 8, 2018.

We have assembled our comments in three main sections:

1. Overall impression and recommendation;
2. Major comments; and
3. Comments specifically related to the Middlebrook well.

1. Overall impression and recommendation

The groundwater model has been developed to support a *scoped* Tier Three assessment. The motivations for developing the model are indicated on Page 1 of the report:

- To simulate the drawdown at municipal pumping wells;
- To evaluate potential reductions in groundwater discharge to surface water features under existing and proposed future conditions; and
- To assess the impact of changes in pumping and land use development on municipal wells and other water uses, such as coldwater streams and Provincially Significant Wetlands.

We concur with the recommendation provided on Page 3 of the report: the Centre Wellington Tier Three model has been developed to focus on municipal water supply systems in the Study Area.

The hydrogeology of the Centre Wellington Study Area is complex and historical monitoring has been limited to areas around the existing wells in Fergus and Elora. If the model is applied to predict the potential effects of groundwater takings beyond these areas, we recommend that analyses start with an assessment of the adequacy of the representation of conditions at the locations of the proposed takings.

2. Major comments

1. We recommend that the results of the Tier Three model be better integrated with the results of the Tier Two analyses.

We concur with the indication in the report that, when establishing the model domain for a groundwater flow model, it is desirable to have the model domain extend to natural groundwater flow divides whenever possible. Large rivers or topographic highs such as moraines often act as groundwater flow divides that are commonly used to establish the model limits. It is indicated on Page 2 that the Study Area boundaries were guided by surface water features and interpreted groundwater flow in the overburden and bedrock. However, referring to Figure 1 here, it is clear that the model area straddles several sub-basins of the Grand River Watershed. Although these sub-basins may not be self-contained, they are hydrologically meaningful, and integrated water budgets were developed for each sub-basin during the Tier Two study.

It is indicated in the report that the Tier Two watershed scale model was not selected for use in the groundwater modelling portion of the Tier Three Assessment due to the regional-scale focus of the watershed scale model. Our impression from Figure 1 is that no consideration was given to the boundaries of the sub-basins. In our opinion, these boundaries would have made for a more appropriate basis for setting the limits of the Tier Three groundwater model. Aligning the model with the boundaries of the sub-basins would have provided for a more meaningful integration of the Centre Wellington Tier Three model within its regional context. Since the model straddles the sub-basins it is not possible to check directly the consistency of the components of the water budgets between the Tier 2 and Tier 3 analyses.

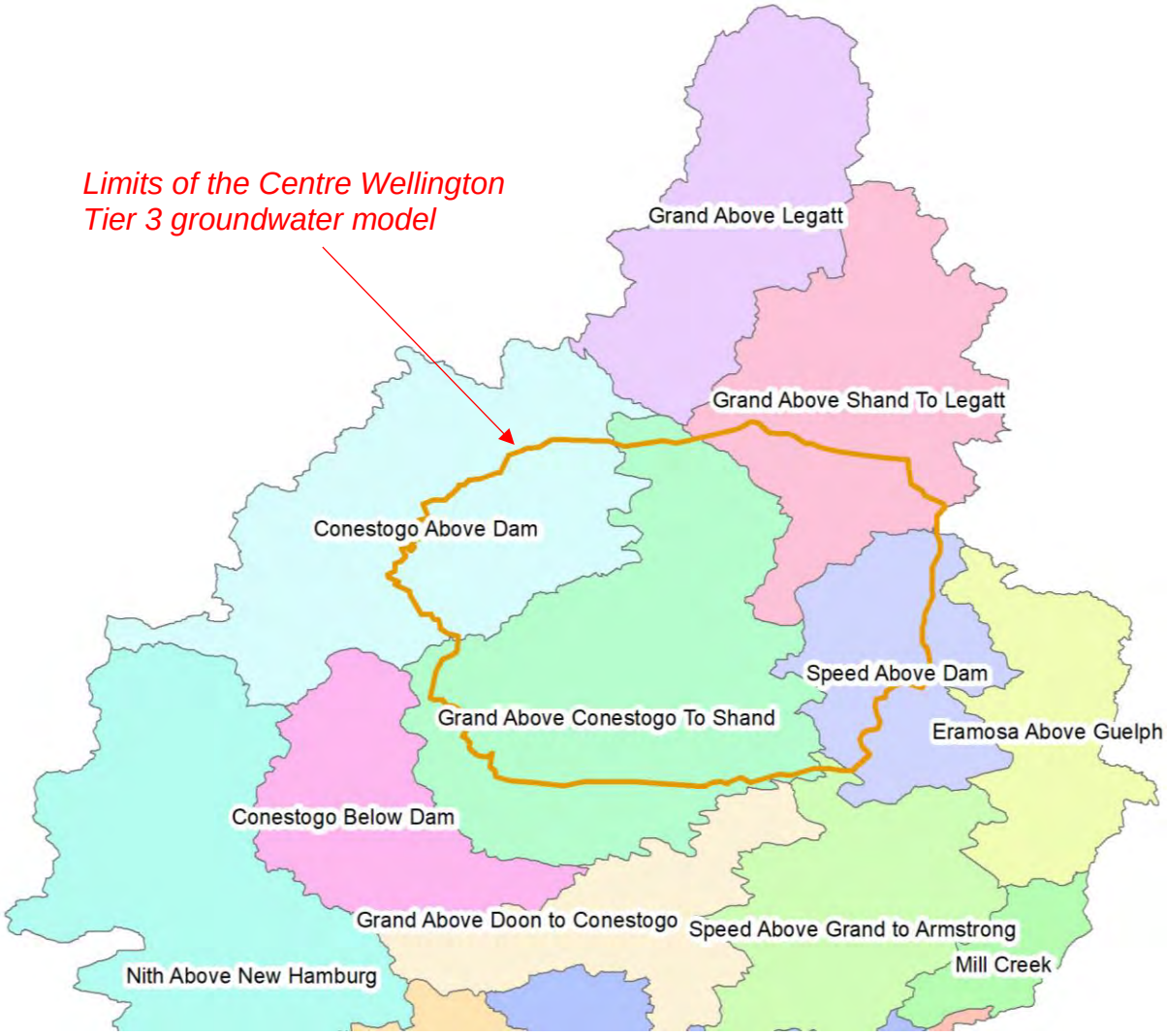


Figure 1. Centre Wellington Tier Three model within the Grand River watershed sub-basins

2. We recommend that additional discussion be provided to support the specification of the model boundary conditions, and the implications of the specification with respect to the water budget calculations.

It is indicated that when designing a groundwater model, the model domain should be far enough away from areas where the model will be used to make predictions, to minimize potential bias that may be introduced by the specification of conditions around the perimeter of the model. In general, this is illusory. Regardless of how far the model boundaries are from municipal wells, the boundaries will have some effect on the local results. This is because the boundaries control the magnitude and direction of regional groundwater flow across the model. The specifications of the model boundaries embed important assumptions in the model regarding entrance and exit points for water. At a minimum, we would expect to see that the simulated flows across the model boundaries are consistent with larger scale results of the Tier Two analyses.

It is indicated in the report that all of the water level elevations applied at constant-head boundary conditions in the model domain were guided by the bedrock water level mapping of values of water levels reported in water well records (WWIS database) near the model boundaries. However, on Page 25 it is suggested that observed water levels from the WWIS have an expected range of uncertainty of approximately 10 m ("i.e., the observed value may be 5 m higher or lower than the value reported in the WWIS"). Our experience suggests that the reliability of a typical water level reported in a water well record may be significantly larger than 5 m. Referring to Figure 11 of the report, it appears that the scatter in the match to WWIS water levels is closer to ±15 m. There is no indication in the report how the low reliability of WWIS water levels propagates through the specification of water levels along the model boundaries or the calculation of groundwater inflows and outflows across the model boundaries.

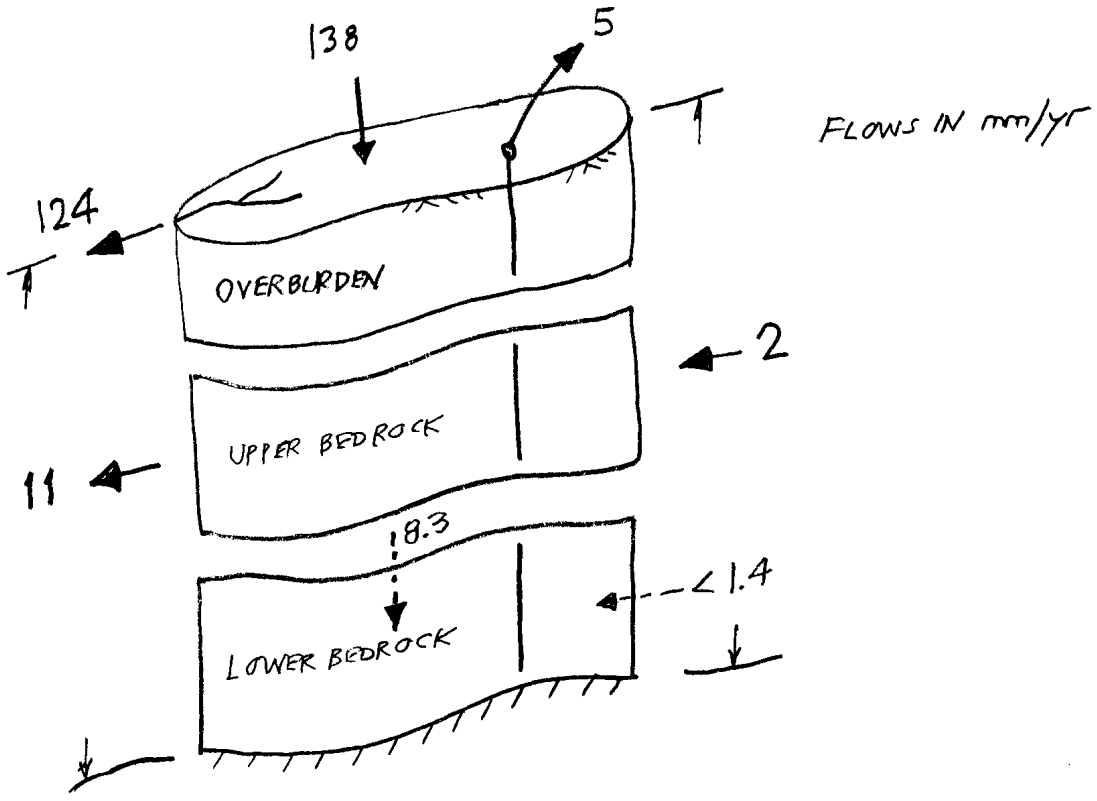
3. The information presented regarding the overall water budget is so important it deserves an extended discussion.

Only an overall groundwater budget is presented (Table 8 of the report). In our Comment #3 we will discuss our reservations regarding this limited presentation. But before we present our reservations, it is important to note that the results on Table 8 are very important and should be discussed further. The results establish a context for appreciating the relative importance of any additional groundwater takings in the Study Area.

The overall water budget presented in the report is reproduced below and illustrated schematically below.

TABLE 8 Groundwater Budget for the Study Area

In/ Out Flow	Component	Flow (mm/y)		Percentage of Total (%)	
		Tier Two	Tier Three	Tier Two	Tier Three
Inflow	Groundwater Recharge	157	138	100%	98%
	Cross-boundary Flows	-	2	-	2%
	Total	157	140		
Outflow	Net Groundwater Discharge to Surface Water Features	125	124	80%	88%
	Groundwater Demand (Pumping Wells)	12	5	8%	4%
	Cross-boundary Flows	20	11	12%	8%
	Total	157	140		



There are two key results in the overall groundwater budget that should be highlighted immediately.

- Assuming that the results presented on Table 8 are reliable, the simulated flows across the boundaries of the model are an insignificant portion of the total water budget. Therefore, in answer to a key question that has been asked previously, "Where does the water come from?", the answer inferred from the modeling is: "From recharge over the model area." 98% of the inflow to the model comes from recharge, and 88% leaves as groundwater discharge to surface water features. Figure 4 is particularly evocative in this regard, there is a well-developed surface water network in the model. We suspect that most of the recharge that enters the groundwater system discharges to surface water features within a relatively short distance.

- The results on Table 8 show that the groundwater takings – that is, the total groundwater takings, not just municipal pumping - represent only 4% of the inflow to the model. That is small, regardless of the criterion anyone uses to assess the relative magnitude of the pumping. We expect that if there was no pumping at all, the 4% would be split between groundwater discharge to streams and outflow across the southern boundaries of the model. Since the NWC Middlebrook well is close to the southern boundary of the model, any pumping from the well would probably be balanced by a small reduction in the outflow across the southern boundary and a reduction in groundwater discharge to the streams that leave the Study Area. It is important to note that the Middlebrook well would not be competing for water with the municipal supplies. We expect that a significant increase in municipal pumping would come at the expense of water available to the Middlebrook well. But it does not work the other way around – pumping from the Middlebrook well would be unlikely to cause a reduction in the water that can be withdrawn for municipal supplies.

The Tier 3 model is to be regarded as a refinement of previous (i.e., Tier 2) modeling efforts. The results of the refined analyses show that pumping is an even smaller fraction of the overall flow in the system than was predicted with the Tier 2 analyses.

4. To be most useful in supporting the understanding of the hydrogeological setting, we recommend that the reporting of groundwater flows be expanded.

As indicated in the previous comment, only the overall simulated groundwater budget is presented, and this serves only to confirm that there is overall consistency between groundwater inflows and outflows. To be genuinely useful, the reporting of the modeling should attach magnitudes to the flows indicated in the conceptual model reproduced here in Figure 2.

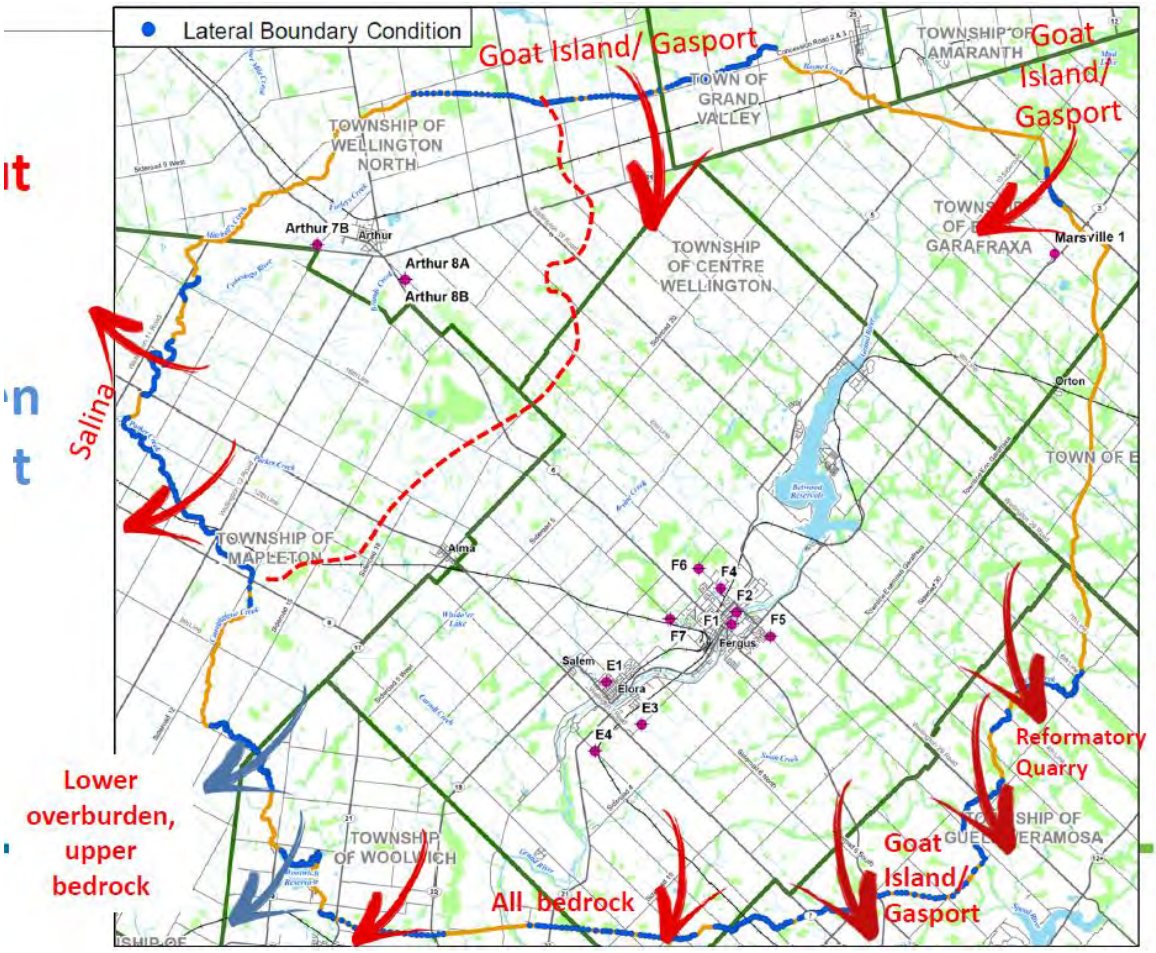
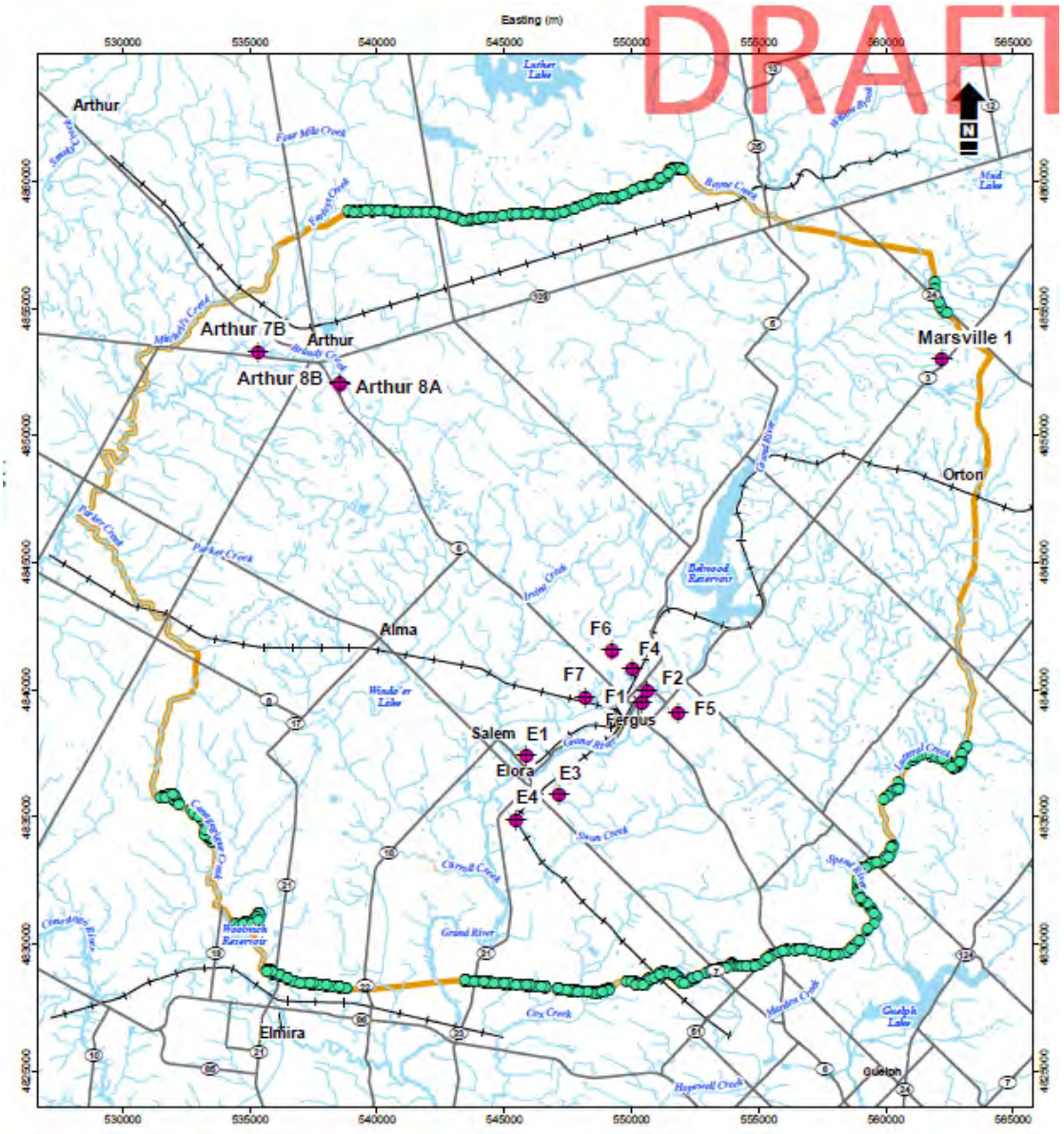


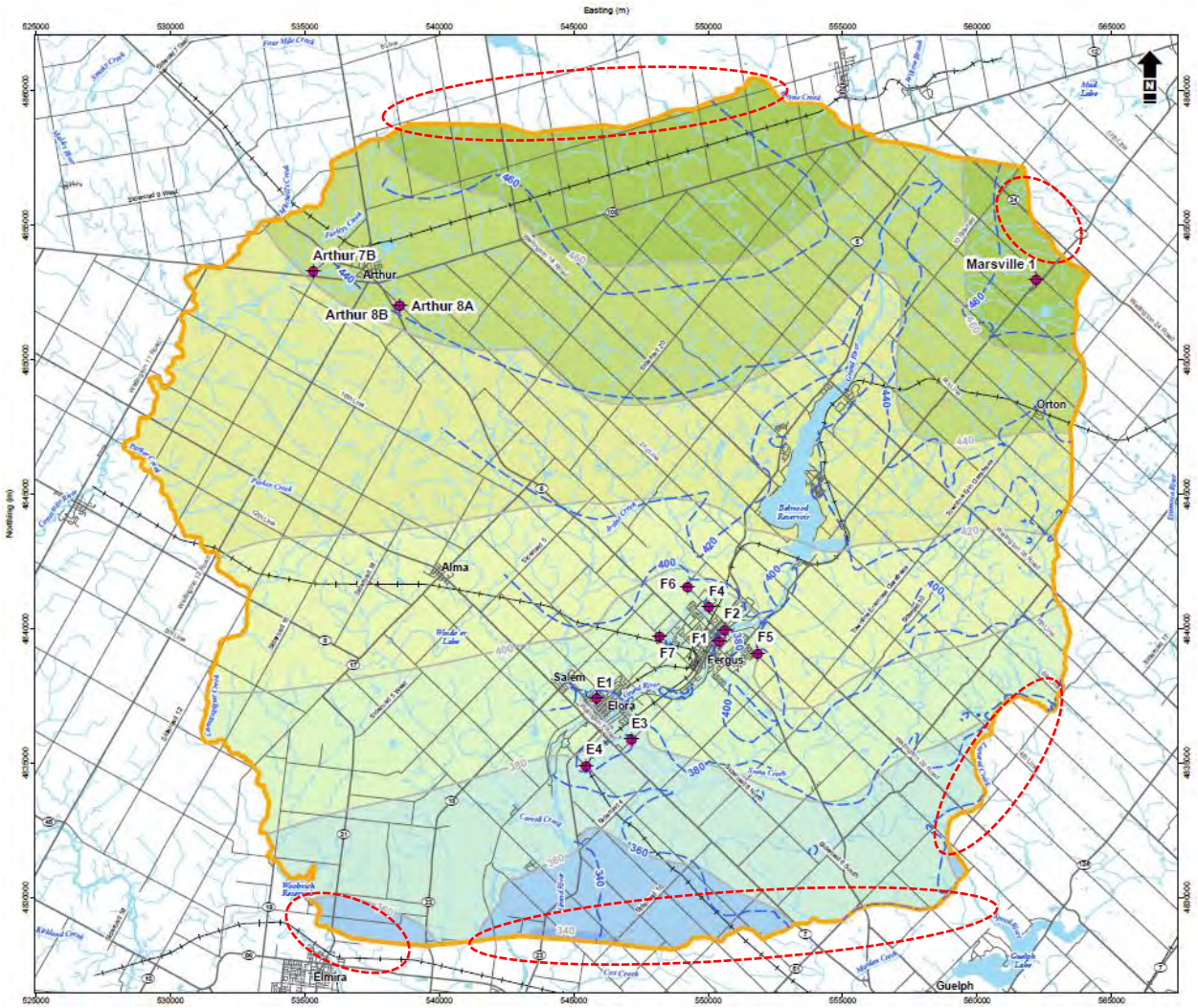
Figure 2. Conceptual groundwater inflows and outflows for the Study Area

5. We recommend that that discussion of the overall groundwater budget be expanded to confirm that the budget is consistent with the results presented elsewhere in the report.

The map of the boundary conditions for the Lower Bedrock Aquifer is reproduced below from Figure 5 of the report. The green circles denote sections along the perimeter of the model along which the groundwater levels are specified, thus allowing water to enter or leave the model area from areas outside the model. As shown in the figure, these sections are relatively long.



The map of the calculated groundwater levels in the Lower Bedrock Aquifer is reproduced from Figure 18 of the report. The red ellipses identify the sections of specified groundwater levels. The spacings of the contours suggest that the flow across the model area is relatively uniform. At first glance, it appears that the inflows and outflows must be correspondingly relatively large. However, referring to Table 8, the *total* cross-boundary flows comprise only a small portion of the water budget (2 mm/140 mm for inflows and 11 mm/140 mm for outflows). This does not appear to be consisent with the clear, general north to south flow patterns shown in Figure 18. Are the lateral flows into and out of the Lower Bedrock Aquifer really that small?



6. It would also be valuable to see the results of a complete water budget for the Study Area.

It is possible to develop a complete water budget, not just an overall water budget for the groundwater model. Matrix Solutions indicate on page 17 that the GAWSER streamflow generation model was updated slightly for the Tier 3 study. Therefore, all of the components of the water budget have been calculated in the analyses. It would be useful to know how much of the annual average precipitation over the Study Area ends up as recharge to the groundwater system. Referring to Table 8, the total recharge is 138 mm/y. As a first guess, the average annual precipitation is probably about 1000 mm/y, so the recharge is actually a relatively small fraction of the precipitation. As a rule-of-thumb in Ontario, we usually assume that the recharge is about 30% of the precipitation. Are we correct in suspecting that in this model area, half of the infiltration never even makes it to the water table as recharge, instead discharging as shallow interflow to streams (i.e., interflow)?

7. The components of the water budget should be expressed in terms that can be understood against any pumping rates.

In our opinion, it is important to see the flows expressed in terms that can be understood against any pumping rates: m^3/d rather than mm/y [to convert to flow rates we'll have to know the model area, multiply the reported values by that area, and then convert units].

It would also be useful to know whether the perfect flow balance that is reported is actual output from the FEFLOW model, or whether Matrix Solutions has had to re-balance the FEFLOW results to end up with outflows that match inflows exactly.

8. We recommend that additional discussion be provided of the implication of the data gaps identified in Sections 7.1 of the report.

Important data gaps are identified in Sections 7.1.1 through 7.1.4. We concur with the text preceding these sections, in which it is indicated that the key question with respect to these gaps is: *What is the impact of those data gaps or unknowns on the model's ability to make predictions?* We would broaden this question to include the model's ability to represent *current* conditions.

For groundwater flow modelling studies, the implications of major assumptions and major data gaps are examined through an uncertainty assessment. The results of an uncertainty assessment are important to understand what really makes a difference in a model: a difference with respect to matching the available data, and a difference with respect to the predictions of the potential effects of changes in the groundwater system. Although an uncertainty assessment is mentioned on Page 45 of the report, as far as we are aware, no uncertainty assessment has been conducted.

We also note that it is now standard practice to use computer-assisted calibration techniques during the development of the model (for example, application of the code PEST). These methods are important for three reasons. First, the use of a code like PEST confirms that the parameter values inferred through calibration are in some sense optimal – no improvement of the overall match to the observations can be achieved for the model structure designed by the analyst. Second, when using a code like PEST, the analyst must assign bounds within which the parameter values can be adjusted. When PEST wants to apply values up to or beyond these boundaries it is a sign that there is a structural problem in the underlying groundwater model. Finally, codes such as PEST provide a formal means of identifying those parameters that affect the match to the available observations. As far as we are aware, no use was made of computer-assisted calibration methods.

9. We recommend that additional results be presented to assess the match between the model results and the calibration targets.

The match to the water levels from the high-quality targets is shown in format in Figure 10. A different format is adopted in Figure 11 to illustrate the match to all of the calibration targets. Goodness-of-fit statistics are reported on Page 27 of the report, but it is not indicated whether the statistics apply to the high-quality or low-quality targets.

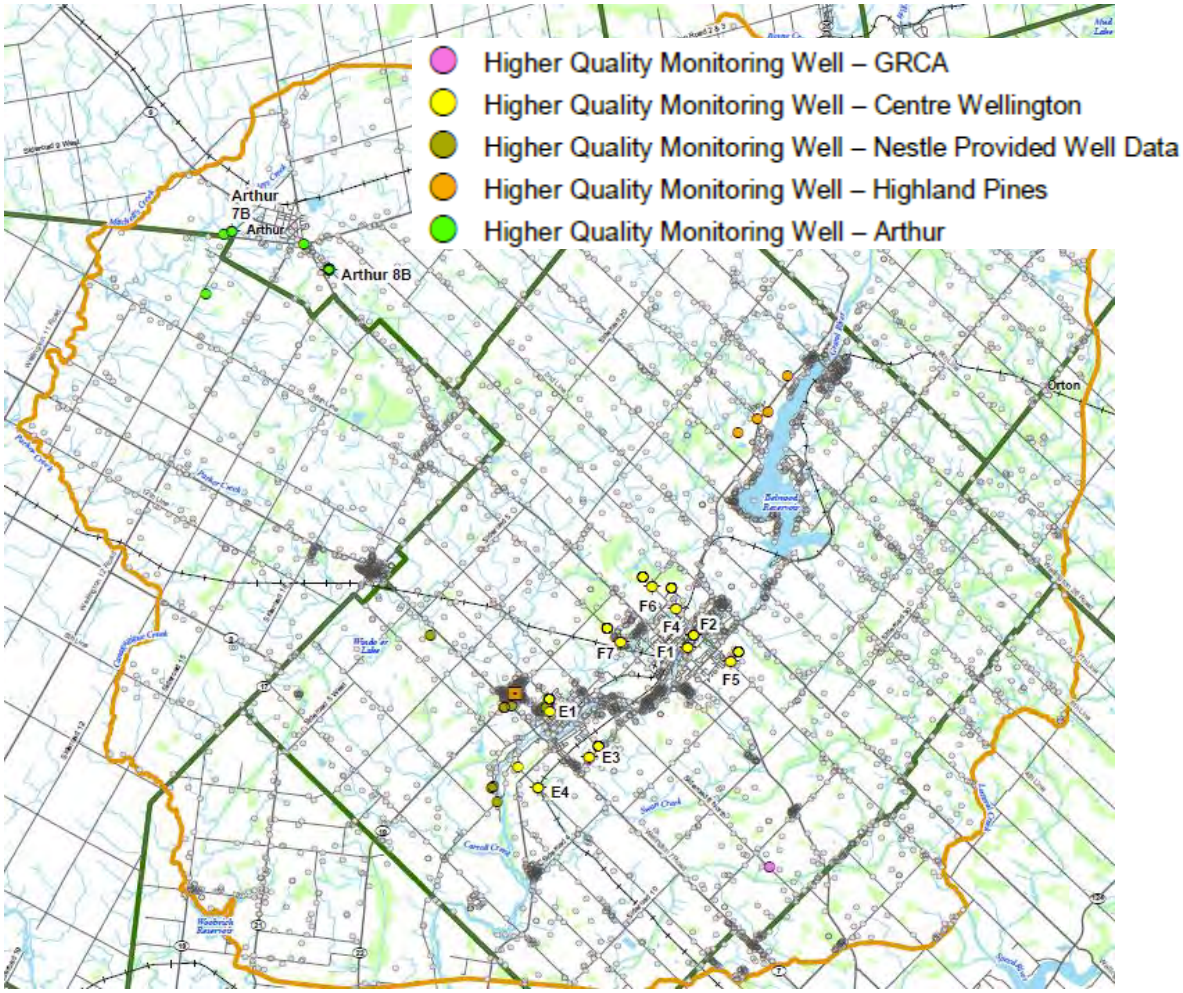
In our experience, the statistic that provides the most insight is the Root Mean Square (RMS) Error. This statistic provides a sense of how closely the model matches a water level target at any one location. It is reported that the RMS Error is 6.3 m. Is this degree of mismatch acceptable to support the delineation of defensible WHPA-Q1?

It is important to note that the mismatch may not be due to systematic model error. If the targets are derived from the water well records, the mismatch may in some cases be due to reported water levels that are not reliable. For this reason, we recommend that the scatterplot shown in Figure 11 be supplemented with a plot of the cumulative probability distribution of the residuals (observed – simulated water level). The cumulative probability plot provides a good means of visualizing outliers in the set of water targets, that is, targets that no model could be expected to match.

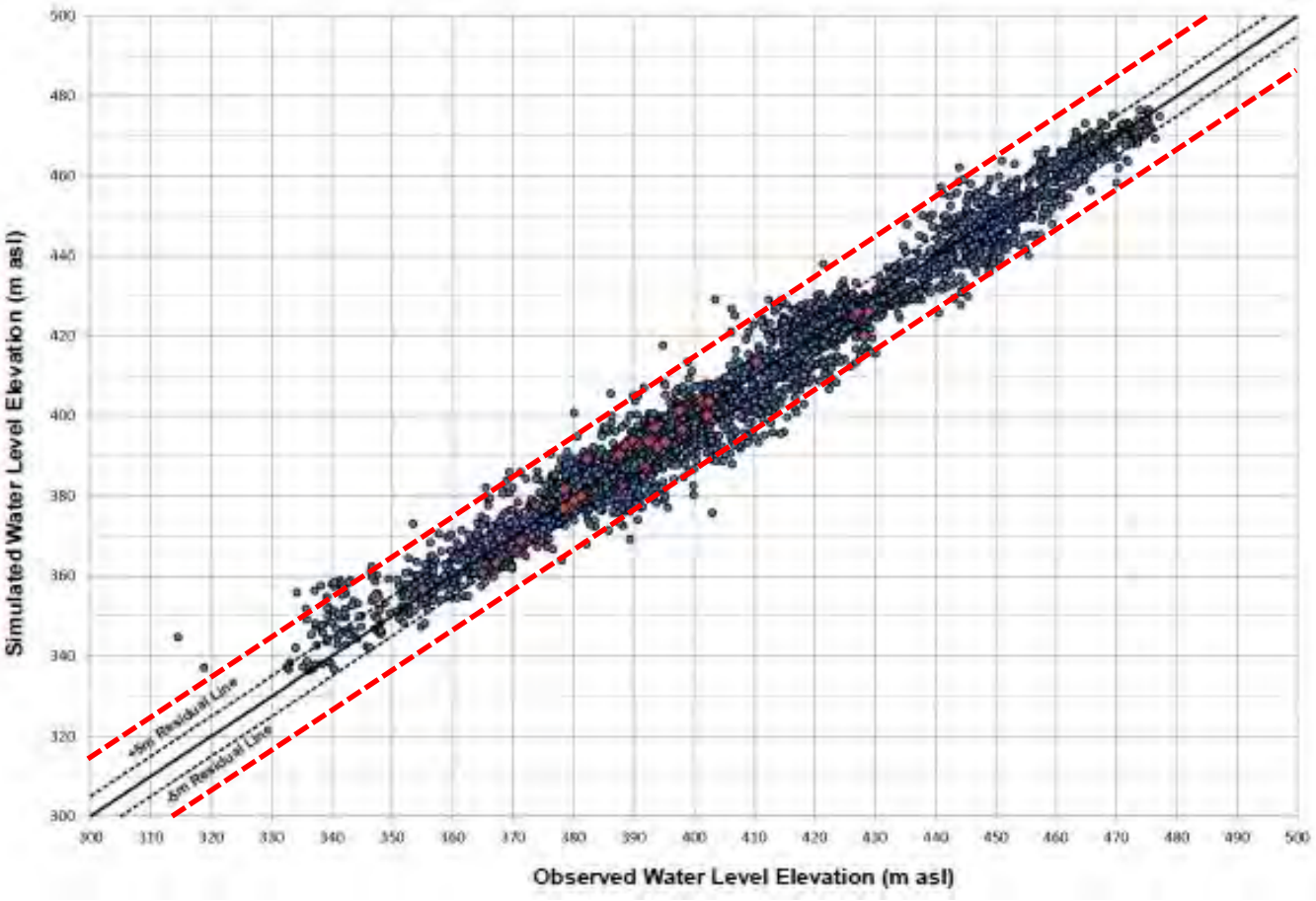
Referring to Figure 10, are the simulated levels on average higher or lower than the targets? In the case of the pumping wells, it is clear that the observed water levels vary over relatively wide ranges. In the case of well F4, the reported range in the observed water levels is from about 353 m asl to 424 m asl, a range of **71 m**. Is it possible that the levels shown for all of the municipal production wells might represent the full ranges of water levels under *both* pumping and non-pumping conditions? Does this make sense considering that the simulation is supposed to be representative of steady-state conditions?

10. We recommend that additional discussion be provided to identify explicitly where there may not be sufficient data to constrain the model results.

The map showing the locations of targets for the model calibration is reproduced from Figure 8 of the report. As shown in the figure, the high-quality targets are concentrated around the Fergus and Elora municipal wells. There are no high-quality targets over much of the Study Area. It is indicated that the model developed by Golder (2013) was considered for use in this project but was not applied because of the advances made to the overburden and bedrock conceptual geologic and hydrostratigraphic models in this area since completion of the Golder (2013) report. What new hydrogeologic data are available since 2013 to update the characterization of the groundwater system? What new wells have been drilled, logged, and equipped for continuous water level measurements?



The well records for private domestic wells cover the Study Area. However, the limitations of the information from these records are evident from Figure 11 of the report. Bands of model mismatch of ±5 m are shown in Figure 11. In our opinion, these bands are much too narrow to provide a sense of how reliable the water level might be at a specific location. As indicated by the dashed red lines that have been added below, bounds of ±15 m provide more realistic impressions of the differences between the model results and the water levels reported in the water well records.



11. We recommend that additional discussion be provided to assess whether the data that are currently available are sufficient to support predictions of potential reductions in groundwater discharge to surface water features under existing and proposed future conditions.

A demonstration of the ability of a model to match flow targets is important for two reasons. First, a match to flow targets is a more stringent confirmation of the reliability of a model compared to matching water level targets. Second, achieving a good match provides some assurance that the model predictions with respect to flows may be reliable. A good match is reported between the interpreted average annual baseflow at the Irvine Creek gauge (0.7 m^3/d, with a seasonal range from 0.2 to 1.6 m^3/d) and the model-simulated groundwater discharge upstream of the Irvine Creek gauge, 0.6 m^3/d. However, in our opinion, one point along a relatively small stream is not a sufficient demonstration.

The results of the modeling indicate that 98% of the inflow to the model comes from recharge, and that 88% leaves as groundwater discharge to surface water features. This suggests that any additional groundwater takings will represent water that would otherwise discharge to streams. However, data to support inferences of changes in groundwater discharge to streams are very limited. A model is only as good as the data that available to check its calculations. To assess the impacts of any planned additional groundwater takings, continuous monitoring of streamflows at additional monitoring locations will need to start well ahead of the start of the takings.

3. Comments specifically related to the Middlebrook well

The ability to accurately represent conditions around the Nestlé Waters Canada (NWC) Middlebrook well is not only of keen interest to NWC. The potential for development of groundwater takings at the Middlebrook well has been one of the motivations for the Centre Wellington Tier Three Water Budget Study. In this section we offer comments specifically related to the representation of conditions in the vicinity of the Middlebrook well.

1. The data from a high-quality Ontario Geological Survey (OGS) multilevel well close to the Middlebrook well do not appear to have been included in the analyses.

The OGS borehole DDH5-09 is not indicated in the figure that shows the high-quality wells that have been considered in the calibration. Elizabeth Priebe has indicated to us that the data from two rounds of water level measurements have been provided to the study team. In Figure 3, profiles of hydraulic head from the two rounds are superimposed on the stratigraphic interpretation of Brunton and Brintnell (reproduced in Priebe and Lee, 2016). Continuous water level data have also been collected but are not yet available (E. Priebe, personal communication August 1, 2018).

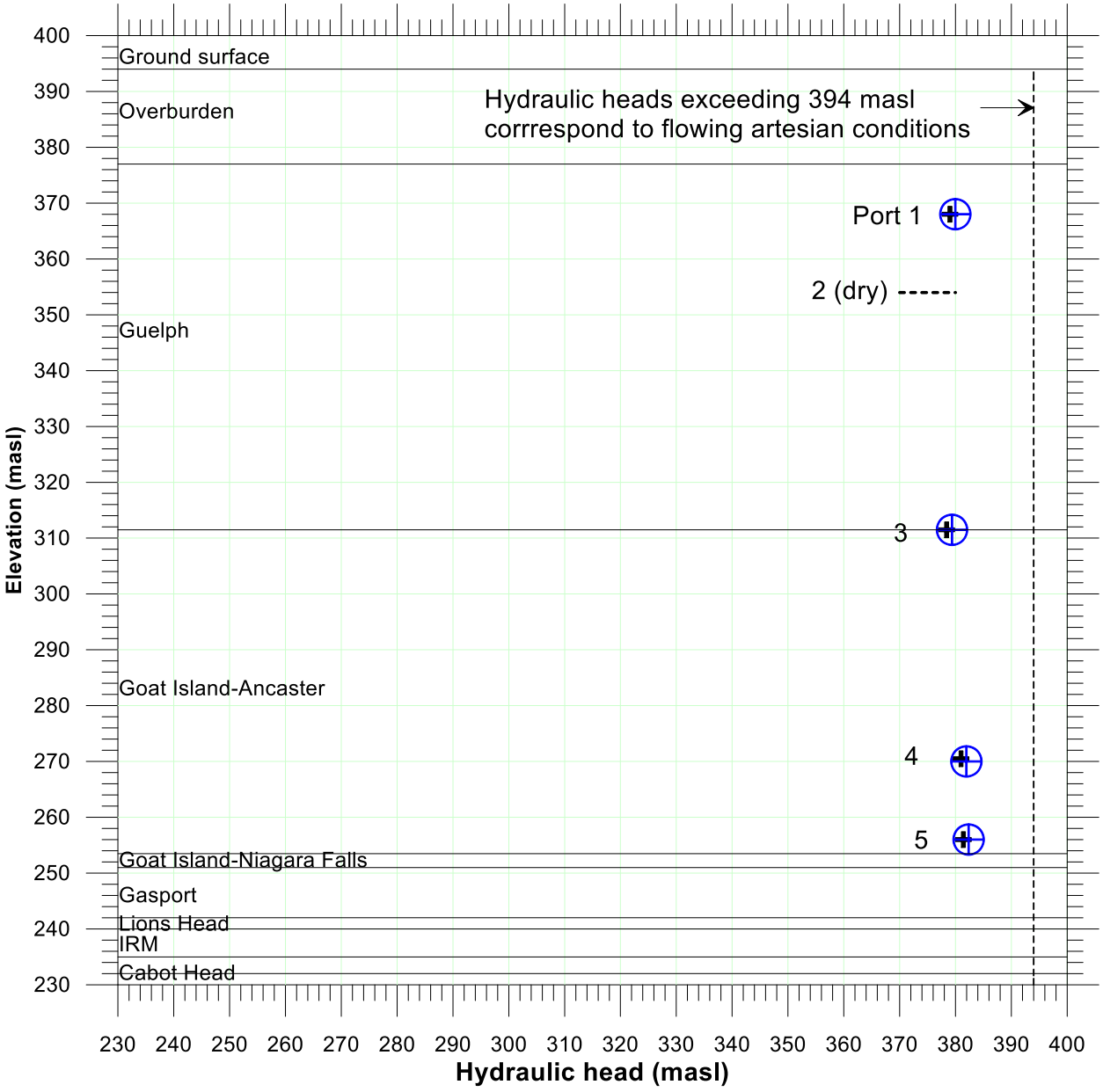
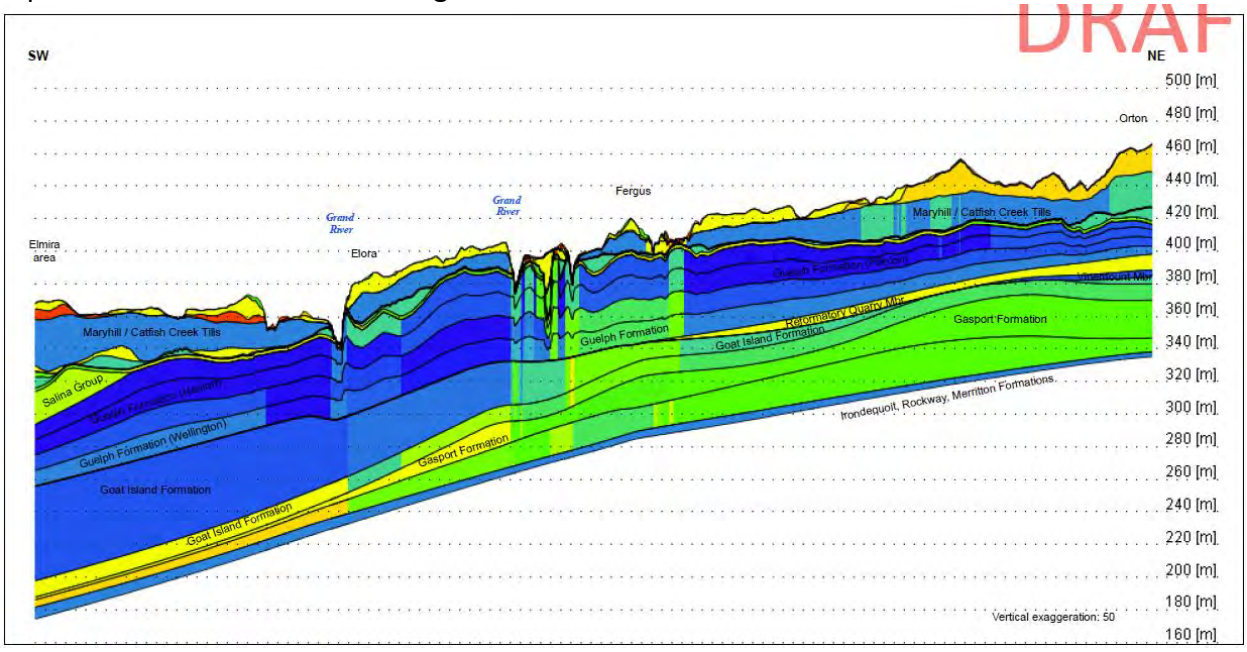


Figure 3. DDH-05 profiles of hydraulic head (data from the Ontario Geological Survey)

2. It is not clear how the Middlebrook well has been incorporated in the analyses.

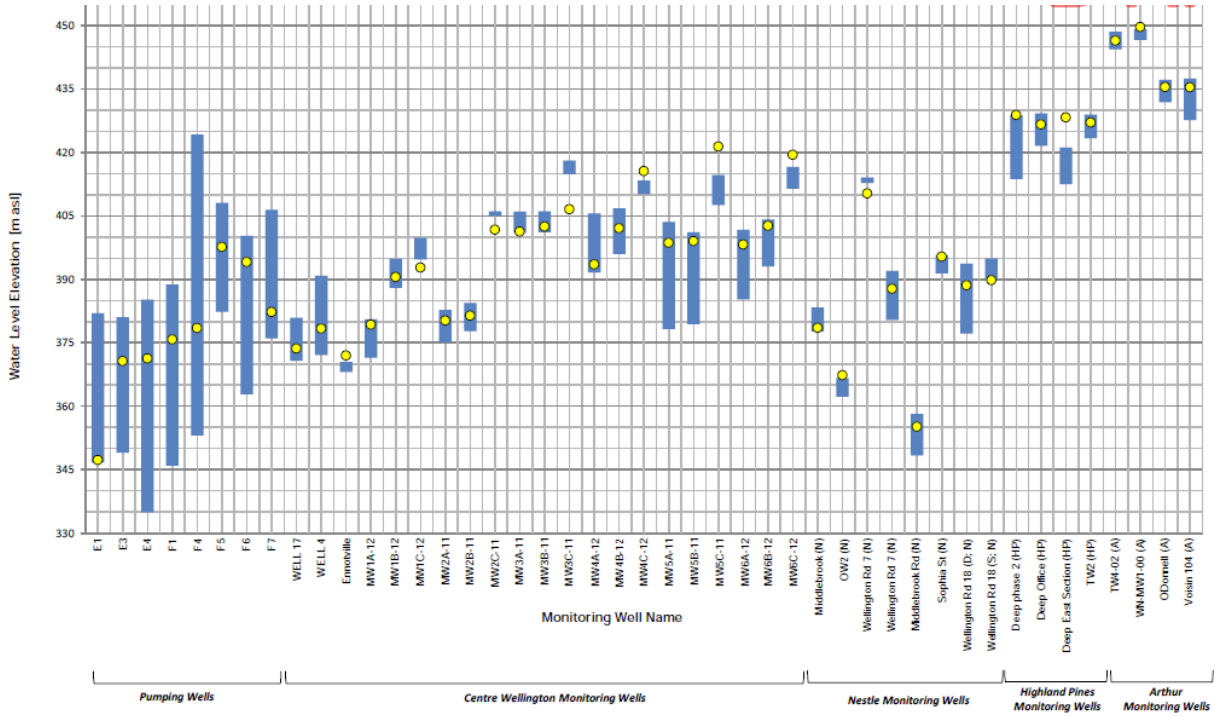
The flow profile and photos from the downhole video collected in the Middlebrook well show that the flow to the long open-interval well is limited to a zone at the lowermost 2 m of the well (Lotowater 2015b). Lotowater describe this zone as a "cavern". This zone is interpreted to provide over 95% of the water that enters the well. Based on cross-section through the model, reproduced here from Figure 15 of the report, we place the water-producing zone of the Middlebrook well at the bottom of the Goat Island Formation. How is the well simulated in the model? Is the well effectively open across only model layer 19, consistent with the results from the flowmeter profiling or is the well simulated to be open across its entire length, and the model correctly simulates that the flow is concentrated at its bottom?

Frank Brunton (OGS) interprets the lowermost production zone in the Middlebrook Well, and the fracture zones noted in the municipal pumping wells as evidence of karst in the Study Area. The borehole log of DDH-05 presented in Brintnell (2012) includes references to fracture zones within the well as "karst" or "rubble zones." These areas with enhanced fractures exist at many boreholes within the Study Area; however, mapping the three-dimensional continuity of these zones of enhanced transmissivity is difficult due to the irregular nature of bedrock fractures and the limited extent of high quality data outside the Fergus and Elora areas. As it is difficult to map in three dimensions the locations and spatial distributions of these zones, it is difficult to capture this information within a groundwater flow model.



3. It is not clear what data have been matched around the Middlebrook well.

Figure 10 of the draft modeling report shows the match to the “higher quality wells”, with the Middlebrook well included among the 8 Nestlé Monitoring Wells. The reported simulated water level for the Middlebrook well is about 378.5 m asl, with the observations reported to range from about 378 m asl to 383 m asl. It is not clear what these levels represent.



Referring to Gartner Lee (2005), the shut-in (i.e., non-pumping) water level in the Middlebrook well is about 15 m above ground surface (the well logs at the time of completion of the well report 47 ft above ground surface, and 20.5 psi [47.3 ft]). For a ground surface elevation of 365 masl, this corresponds to a hydraulic head of about 380 masl. This represents the composite water level for the long open interval of the well. The packer testing conducted by Lotowater (2015) showed that when the water-producing zone at the bottom of the well is isolated, there is a head differential of about 14 and 17 m between the water-producing zone and the shallow bedrock. Our interpretation of the separation between water levels when the flow zone at the bottom of the well is isolated, or the averaging of water levels when it is not, is illustrated here in Figure 3. Has any attempt been made to match the data and the well discharge rate observed under flowing conditions?

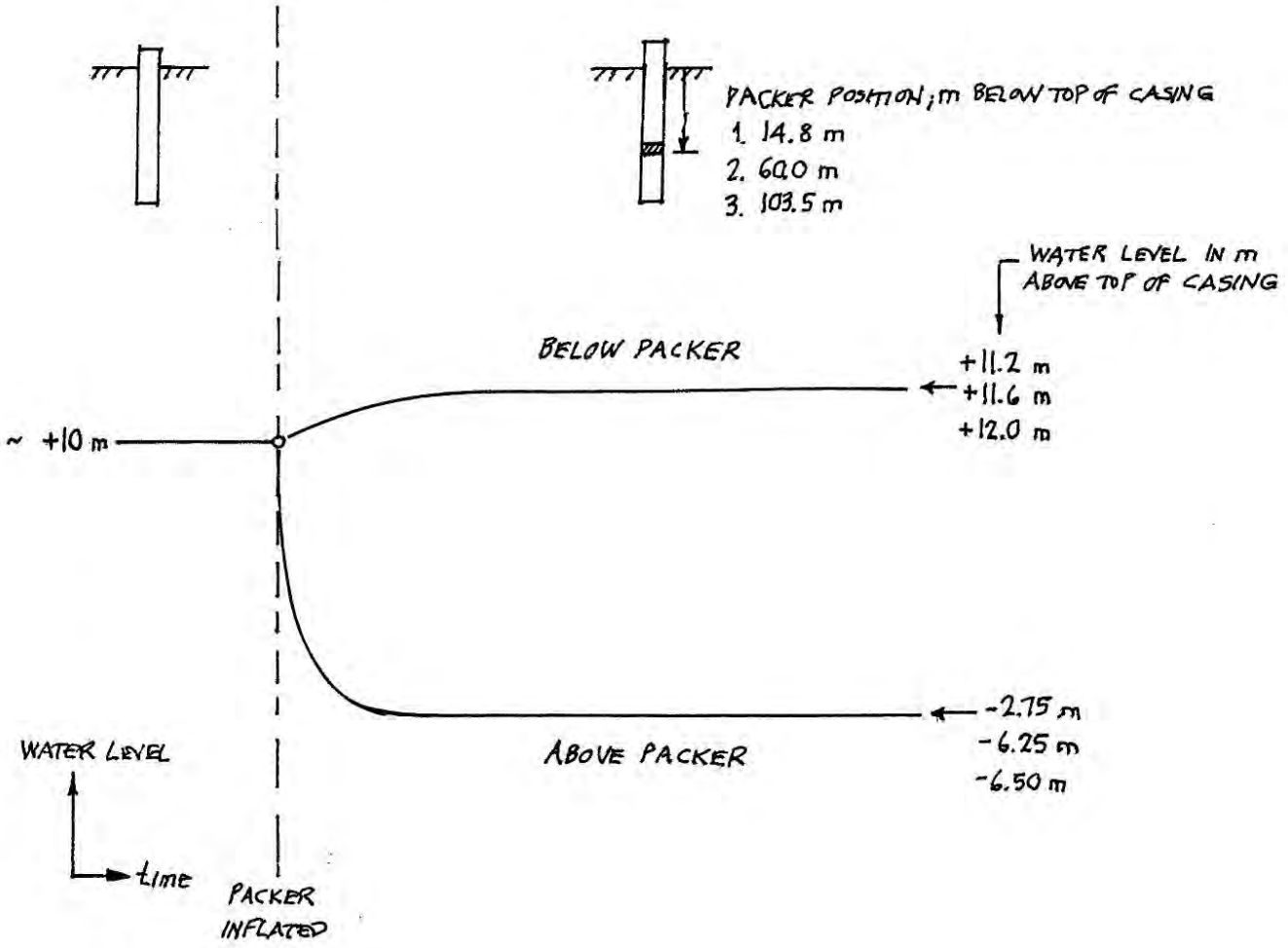
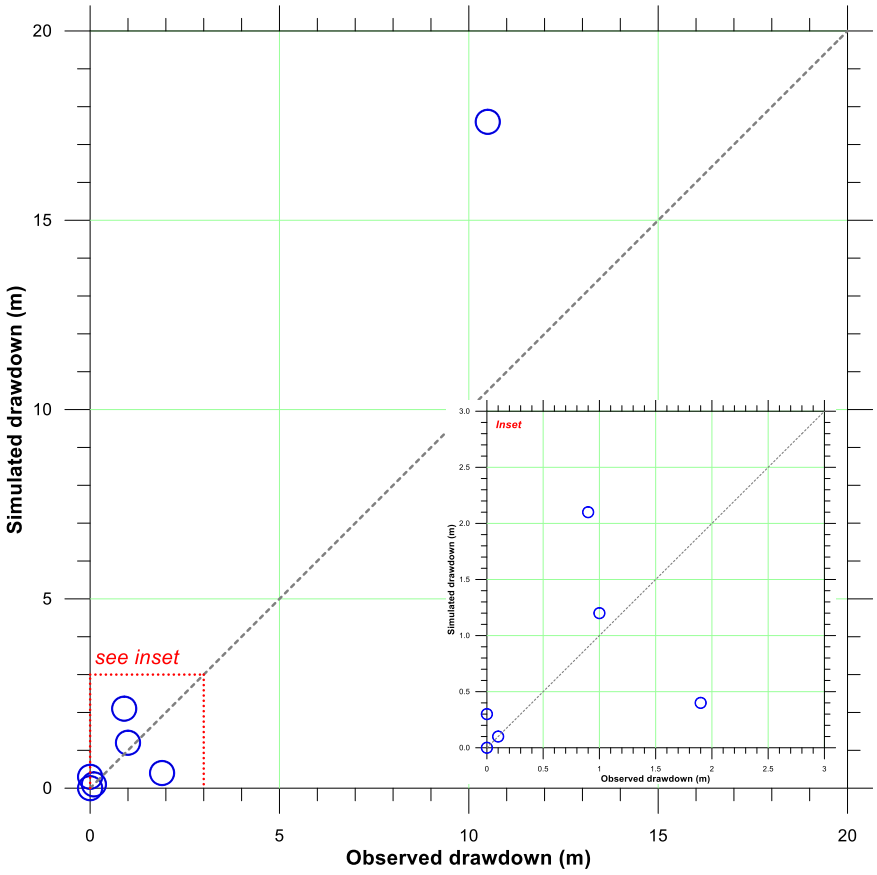


Figure 3. Conceptual model for shallow and deep bedrock levels at the Middlebrook well

4. It is not clear what data from the Middlebrook 30-day pumping test are matched.

On Table 5 of the report (page 33). Matrix Solutions refer to "Simulated and Observed Drawdown during the 30-day Middlebrook Pumping Test". What does "during" mean? Are these the simulated drawdowns at the end of 30 days? We are not convinced that they have as good a match as they claim. It is noted in the report that the model does not reproduce conditions around the pumping well. This is important, as the drawdowns in the well are so much larger than the drawdowns observed at the other observation locations. The observed drawdown (and it is really a stabilized drawdown) is 10.5 m, while the simulated drawdown of 17.6 m is much larger. It is indicated in the report that conditions around the Middlebrook well are a "local feature" and that the equivalent porous medium approach used in the study was able to represent the hydraulic responses in the larger groundwater flow system. We are not convinced. The matches to the observed drawdowns at W2 and W4 are not very close either. Our understanding is that one of the objectives of the Tier 3 model was to represent conditions at the Middlebrook well reliably; in our opinion this objective has not yet been accomplished.



5. It is not clear what material properties at the Middlebrook well have been inferred through calibration.

The data from the Middlebrook well provide important insights into the presence of a karst feature at the Middlebrook well that acts to attenuate the drawdowns in the pumping well. Our analyses of the data suggested that the transmissivity immediately at the well is about 300 m^2/d, in contrast to the bulk-average transmissivity around the well of about 60 m^2/d. The discrepancy of these two estimates is consistent with the observation of voids at the bottom of the well in the Lotowater video logs. What transmissivities have been inferred in the model at the Middlebrook well?

Closing

We appreciate the opportunity to review the draft **Groundwater Flow Model Development and Calibration Report**. We hope that our comments are useful. If you have any questions regarding our comments, please contact Christopher Neville by E-mail at *cneville@sspa.com*.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

Christopher J. Neville, M.Sc., P.Eng.
Senior Hydrogeologist, Associate

- Christopher J. Neville: PEO #100013705
  (valid through December 31, 2018)
- S.S. Papadopulos & Associates, Inc.: PEO Certificate of Authorization #100077381
  (valid through June 30, 2019)

References

Brintnell, C., 2012: Architecture and stratigraphy of the Lower Silurian Guelph Formation, Lockport Group, southern Ontario and Michigan, M.Sc. thesis, The University of Western Ontario, London, Ontario. https://ir.lib.uwo.ca/etd/632

Gartner Lee Limited, 2005: Middlebrook Water Source – Elora – Long Term Source Sustainability, prepared for the Middlebrook Water Co. Inc., March 2005.

Lotowater Technical Services Inc., 2015: Middlebrook Well Video, Flow Profiling and Packer Testing (draft), prepared for Golder Associates Ltd., Paris, Ontario, May 21, 2015.

Matrix Solutions Inc., 2017: Centre Wellington Scope Tier Three Water Budget Assessment: Physical Characterization Report (draft), prepared for Grand River Conservation Authority, Matrix Solutions, Guelph, Ontario, September 2017.

Priebe, E.H., and F.R. Brunton, 2016: Project Unit 11-032: Regional-Scale Groundwater Mapping in the Early Silurian Carbonates of the Niagara Escarpment: Final Update, in *Summary of Field Work and Other Activities 2016*, Ontario Geological Survey, Open File Report 6323, p. 29-1 to 29-10.

Priebe, E.H., and V.L. Lee, 2016: Groundwater Hydrochemistry Data for Multi-Depth Well Sampling in the Early Silurian Carbonates of the Niagara Escarpment Cuesta: Support Document, Ontario Geological Survey, Miscellaneous Release – Data 337.

APPENDIX G

COMMUNITY LIAISON GROUP COMMENT RECORD

Note: the meeting described in the preceding meeting summary (August 12, 2018) included discussion of comments from the Ontario Geological Survey, summarized in a memo dated June 30, 2018. This memo is found in Appendix F, found here.

DRINKING WATER SOURCE PROTECTION
Our Actions Matter

LAKE ERIE SOURCE PROTECTION REGION

Centre Wellington Scoped Tier 3 Water Budget Study: Discussion on draft Groundwater Flow Model Development and Calibration Report

Location: Grand River Conservation Authority Head Office, Cambridge
Date: Sept 27, 2018
Time: 10:00 am to Noon

Meeting Objective: To review and discuss comments provided by Save Our Water (SOW) on the draft Groundwater Flow Model Development and Calibration Report.

Discussion Items: A list of discussion items are included in the meeting agenda in Appendix A. These discussion items reference initial comments provided by SOW, which are included in Appendix B.

Participants: A list of participants is available in Appendix C.

Point of Recognition: The meeting began by recognizing that Ian MacRae (in attendance) is currently a candidate for Centre Wellington Council. The Clerk, Kerri O'Kane, has advised that as Mr. MacRae has attended meetings in the past as a SOW representative, there is no conflict between his attendance at this meeting and municipal election rules, as the circumstance is similar to incumbent Councilors carrying on with meetings during the election period. The potential for conflict exists, however, if information gleaned from the meeting is used during campaigning; Mr. MacRae agreed that he would not use information from this meeting during campaigning.

Summary

This summary is organised by agenda point (see Appendix A for the agenda). Each agenda point is in reference to written comments provided by SOW, with the specific references noted in parentheses at the end of each agenda line (SOW comments are available in Appendix B).

1. Short-term project (c. 1)

The project team will remove references to 'long-term' from the report. SOW inquired if the modelling was still confined to 2031 due to limitations relating to infiltration levels and density. The Township responded that the Provincial Policy Statement, which provides growth and density targets, only projects to 2031. Modelling includes changes in development and related changes to impervious areas; as growth and density targets only project to 2031, modelling cannot project densities and impervious area cover past 2031.

Matrix added that the Tier 3 evaluates wells that are permitted or specifically planned to be permitted; potential future wells are not included. The Water Supply Master Plan (WSMP), which is currently in progress, does provide potential additional well sites. Moving forward, it will be important to look at the WSMP and the model together to assess the timeframe past 2031.

2. How will future water-taking be balanced? (c. 10)

Matrix is starting the risk assessment process, which will include an assessment of how future water taking affects the overall water balance (i.e. how additional water takings change groundwater flow as compared to current conditions).

3. How can ecological impacts be assessed? (c. 11)

Matrix noted that the Tier 3 framework is not a detailed ecological risk assessment and is meant to be a screening process. The study will identify areas where there is a potential for ecological impacts based on thresholds described in the Province's Technical Rules for completing Tier 3 water budget studies. This information will provide those looking for a new water supply guidance on where to complete additional monitoring and characterization efforts to address potential ecological risks in greater detail.

SOW inquired if the takings from bedrock aquifers increase from 4% to 6%, where the extra 2% of water takings will be sourced from, and if the source could be the overburden and upper bedrock layer, outside the study area, or from river recharge. Matrix provided discussion on groundwater movement through the shallow and deeper aquifer systems.

SOW noted that it can take 50 years for water to move down into bedrock aquifers, and are concerned this time requirement will not allow for the impacts of increased water takings from bedrock aquifers to be understood and noticed until many years after increased takings begin. Matrix acknowledged this and noted that the model will provide good direction on what the impacts might be. SOW suggested it would be impossible to measure where additional water takings from the bedrock aquifer would be sourced from (in terms of surface water recharging the aquifer). Matrix noted that they would not know with certainty, but that modelling helps identify potential areas for further investigation, which helps identify where to spend limited monitoring resources.

SOW inquired where the best places for spending additional monitoring resources would be. MECP and the Township explained that it is possible to investigate impacts to surface water features through pumping tests by monitoring surface water features during the tests to pick up interferences. However, the scope of monitoring can be limited by budget constraints and complex environmental features such as the fractured rock environment in Centre Wellington. The groundwater model provides insight for siting potential monitoring locations when trying to use limited resources to monitor in an effective way. The Township further noted that there are future steps in the process, past the modelling stage, including class environmental assessments (EAs) and water studies. The Tier 3 is not the end of the process but is more of a screening tool to identify potential risks and areas in need of further investigation.

4. Conforming to provincial wetland strategy (c. 15)

Matrix noted that the Tier 3 is not a wetlands assessment process. The hydrology of wetlands is often not understood until they are studied at a higher level of detail. Matrix provided further examples of areas within the Grand River watershed with differing wetland hydrology regimes.

MECP noted that some SOW comments seemed to relay unhappiness that a more holistic approach to water management was not being used. That was a conscious choice by the Province as the scope of the technical studies was not extensive enough to evaluate all impacts definitively.

SOW noted that assessing impacts on Provincially Significant Wetlands (PSWs) and cold-water streams are important. The group reiterated that assessing both PSWs and non-PSWs are important. MECP noted that PSWs and cold-water streams are captured in subsequent evaluations, such as Permit to Take Water applications. It was also noted that the Ministry of Natural Resources and Forestry (MNRF) was involved in the development of the wetlands portion of the Tier 3 Technical Rules and in the decision that the Tier 3 would look at cold water streams and PSWs.

5. What portion of the 6% is available to the Township's wellfield (c. 8)

Matrix responded that theoretically all of the 6% is available if municipal wells are spread across the area. The operational challenge, as identified in the Water Supply Master Plan, is the function of the physical nature of pumping wells, where to place these wells, and how deep and efficient they have to be so they don't affect other nearby wells. Therefore, it is actually a smaller piece than 6% that is available for sustainable pumping.

SOW noted that Figure 6 of the Groundwater Model Development report shows recharge areas. If one looks at flow boundaries, the flow would exit from the areas of recharge, with the lowest recharge area around the municipal wells. Matrix noted that the recharge map shouldn't be confused with leakage into the aquifer. Areas with high recharge rates also have larger baseflow to cold water streams. In till areas, the water doesn't travel to cold water streams and tends to migrate into the aquifer or run off to surface water features. Therefore, the map of recharge doesn't reflect what is available for municipal takings.

SOW inquired if Fergus and Elora could be getting water from near Elmira, as a part of the 6%. Matrix provided an explanation as to how water from the Elmira area does not contribute to the Centre Wellington water supply.

6. Not all of the water available to Centre Wellington's municipal wells is usable (c. 18)

Matrix explained that all Tier 3 studies assume the water supply is potable or treatable to a potable level; non-potable (or water that cannot be treated to become potable) is not included in the rate of available water.

Matrix noted that the source protection water quality process is meant to accomplish two things: to identify threats to water quality, and to identify the sources of contamination. This is a parallel process to the Tier 3 study. Further discussion ensued with regard to the Water Supply Master Plan and MECP's concern with contaminated sites in fractured rock environments.

7. Impact of Middlebrook should be assessed with all aspects of the Tier 3 (c. 3)

Matrix discussed how the project is scoped to address the Middlebrook Well throughout the process. The Middlebrook Well was used in the model's calibration, and the project team and peer reviewers find it acceptable as to how with how the model represents the Middlebrook Well pumping test. The next step is to evaluate various scenarios and assess how the aquifer can support municipal water supplies and other permitted water takers currently, and into the future.

8. Groundwater infiltration to Fergus sewer system (Additional question Sept. 22)

SOW inquired if the Fergus sewer system has combined sanitary and storm sewers (combined sewage overflows (CSOs)). The Township responded that they do not have any CSOs.

Matrix noted that the groundwater model does not include this infiltration. As it would have likely discharged to a stream in the absence of the sewers, this infiltration doesn't affect the overall water balance. Therefore in the model, infiltration into sanitary and storm sewers should not be thought of having a significant impact on the water that flows into the aquifer.

Matrix provided further discussion on the water budget and how uncertainty is assessed. The team noted the feedback provided by SOW is helpful as it helps the consultants understand how to best report on the many values they have found.

9. Total demand from households on private wells is low (c. 16)

The value provided in the draft groundwater modelling report is a typo, and will be revised to state 251 litres per person per day.

10. Groundwater boundary flow (c. 9)

Matrix provided discussion around how boundary conditions were assigned in the groundwater model as they relate to the overburden and bedrock layers, and how groundwater flows across the boundaries. Matrix further explained how they are undertaking an assessment of the model's sensitivity to the uncertainty of boundary conditions and will include a text explanation in the Groundwater Flow Model report as to why these areas were assigned. The uncertainty analysis which will assess how uncertainty around boundary conditions impact model output. MECP added that the uncertainty analysis should also provide a degree of confidence around where the water in the deeper groundwater system comes from.

11. Future land uses within the study area (c. 4)

Matrix noted that they will address future land use and how it could potentially influence groundwater recharge as a part of the project. Future land use can only be assessed through information available in the Official Plan. Additional water demands for future land uses are not evaluated as this is an unknown and cannot be predicted.

MECP expanded that the purpose of the study is to ensure that water is available for future municipal water needs including growth. The study does not include speculation about water demand associated with future land uses. The process municipalities go through to anticipate their growth is extensive and technical and has a public commenting process. The legal framework for water states that the Province doesn't own water, and they also don't assign and reserve it. The Tier 3 study will evaluate scenarios that include the Middlebrook Well because there is a more substantiated interest for additional water taking in that area.

SOW inquired if there is pumping data from the Middlebrook well. MECP stated there is data from a pumping test that was conducted in 2004, and the geological information from that well is informing the model. In the future, if a proponent were to come along with a proposed water taking, it is evaluated using the model and looking at the potential impacts on existing users.

SOW explained that although Middlebrook Well had a pumping test, the well wasn't used to any degree (although it was permitted). Additionally, the assumptions are the population will grow, but in the scenarios, there are no assumptions that business, industry and demand will grow. MECP replied that the challenge is establishing how the Ministry regulates and plans ahead, because though plans are developed, they are not firm. The Ministry can pick some sites and develop some models, but the challenge for the Ministry is how to make decisions on current takers, while somehow anticipating future takings in a way that won't be challenged and appealed, as the Ministry wouldn't have the technical grounds to not permit that water taker.

SOW inquired if the 2004 pumping test data was compared to data from the municipal wells for interference. Matrix did complete this comparison, and there was a response in the pumping test resulting from pumping in Elora. There is a hydrogeological connection as the Middlebrook well is completed in the municipal water supply aquifer. In 2012 there was an approximate two-metre change in water level at the Middlebrook Well as part of the municipal capacity test.

MECP noted that the Tier 3 study is helping municipalities identify the safe available drawdown level for their municipal water supply wells. Municipalities have allowed for conservative estimates to ensure there is protection. If one were to influence the municipal well and draw water levels down below the elevation set, that becomes a negative impact. In private wells, they don't define that impact line. For example, if the interference is below a pump, the Ministry would then ask if the pump could be lowered; this is not interference if both takers could still be accommodated after lowering the pump. The issue is when a taking interferes with operations in a way that cannot be corrected.

12. Private well residences becoming serviced (Additional question Sept. 22)
Matrix responded that as the risk assessment is completed, they will ensure the representation of private wells is consistent with the WSMP.

13. Please explain the 98% (c. 7)
Matrix explained that recharge enters the groundwater system from the ground surface. A small portion of this travels through the upper Guelph Formation. It then flows horizontally through various bedrock aquifers, but most of the water stays shallow, flowing into shallow features such as streams and surface water bodies. Matrix provided further information about the water budget as is contained in the model report, and committed that the risk assessment report would describe the changes in the water budget associated with the future water taking scenarios.

An assumption in the model is what is known about the bedrock aquitard and the upper bedrock in the Fergus and Elora areas. The Ontario Geologic Survey agrees with the assumptions made, but there is still uncertainty over the variability of permeability in the rock. There are different permeabilities of geological features in Guelph; this impacts aquifer water levels. It is difficult to completely understand these features as consultants must rely on the interpretation of current data from existing boreholes and wells.

14. The study does not assess the sustainability of the aquifer (c. 2)
Matrix explained that by definition this is true; the objective of the study is to assess the sustainability of municipal water takings, not to assess what the maximum takings should be.

SOW noted that the study doesn't address the sustainability of the larger regional aquifer. Assuming this aquifer extends to Waterloo and Cambridge, there are assumptions about inflows and outflows into the aquifer that are not addressed. MECP explained that when the Ministry issued the moratorium on new water bottling permits, they did this in part because they realized there was limited research available, and they wanted to change policies regarding how water was used in an informed way. They realized there were limitations to the understanding of the bigger picture of water use in the area. The moratorium provided the Ministry with a pause with which they could do additional investigation. The approach to focusing on the sustainability of municipal supply was a choice made by the Province in developing the framework in order to remain pragmatic; in part because there are some aquifers where there can be a readily defined boundary, and others where boundaries cannot be delineated with certainty. The bedrock aquifers in the Guelph, Fergus, and Elora area have a large extent of coverage, and the aquifer properties change and vary greatly over this area; the Ministry does not have the ability to monitor the entire area and complete water budgets of that type and size, which is why they focus on the municipal availability of water.

SOW inquired if the project team could expand on how to deal with sustainability. They expanded by inquiring if Nestle could acquire a PTTW based on current information even if there is interference with the Elora wells. SOW inquired how, through the regulatory system, it

can be ensured that one private well doesn't stop the municipality from putting in a new well to meet municipal needs. Matrix explained that the Tier 3 process is scoped so that it flags scenarios where there is a potential threat to meeting municipal water needs. If a scenario is flagged as a potential threat to the sustainability of municipal water needs, then that should be considered in the PTTW process. If a risk is identified, then within the PTTW process administrators can request additional information from the proponent in terms of data analysis or further testing, and can consider that information when making a decision around the permit application.

15. Groundwater model needs regular updates (c. 5)

The project team agreed to the need for regular updates to the groundwater model. SOW inquired what plans are in place for that to happen. The Township noted that they are required to submit a work plan to renew permits in 2020. This work plan may trigger updates and additional modelling exercises as a part of their submission for permit renewal.

The GRCA noted that the entire source protection plan program is designed for continuous improvement. It's recognized that groundwater models are assets that need to be maintained to retain value. As there are six Tier 3 groundwater flow models in the Lake Erie source protection region, the GRCA recognizes need to create a more fulsome framework for governance and management; that includes a funding request to the Province for updates. The GRCA is working towards the development of this framework.

The Township noted that they are looking at collecting additional field data (e.g. borehole data); if council approves additional drilling they can install high quality wells to further inform the model.

An example of the use of the Tier 3 model are updates to quality Wellhead Protection Areas using the Tier 3 groundwater model that are in progress this fall.

SOW inquired if there needs to be a longer pause (longer moratorium) to deal with uncertainties. MECP responded that the current government is reflecting on the budget, and although all parties see the need for continuous improvement, this may depend on budgeting. MECP recognizes the models are large pieces of infrastructure that cross municipal boundaries.

The Lake Erie source protection region is in the process of developing guidance for continuously improving their models. Municipalities or source protection authorities could take over management of the models, but any source protection authority with a model that resulted in significant threats have so far requested funding from the province to ensure updates are possible.

The GRCA noted that the Centre Wellington Tier 3 model is owned by the GRCA on behalf of the municipality. MECP noted that asking for funding for maintenance is common, and the

province is hearing this from various groups and they acknowledge the need to upkeep these models.

16. Uncertainties and the risk scenario assessment (c. 14)
Matrix explained that uncertainties for the Centre Wellington Tier 3 are no greater than any other municipal Tier 3 study. There is a lot of high-quality data available in the area, and the Tier 3 study has been designed to be conservative, knowing there is uncertainty present. Matrix will evaluate various scenarios to identify whether any scenarios create a significant risk to the municipal supply and also evaluate the uncertainty related to the identified risk. If a risk is identified, the municipality must identify how to mitigate that risk. Overall it is a very conservative approach.

17. When will the uncertainty assessment be undertaken? (c. 13)
The uncertainty assessment is beginning this fall.

18. Data gap regarding recharge rate through the Tavistock Till (c. 12)
It was acknowledged by the group that this comment was addressed as a part of prior discussions during the meeting.

19. Verifying accuracy (c. 19)
Matrix noted that this comment is connected to the model calibration process. The calibration results show a very good match between the numerical model (simulated data) and the well data (observed data). In the future, when new municipal wells are in place, the model calibration will be evaluated again to assess whether the fit is still appropriate. There is always a need to consistently ground truth the models as time moves forward. Municipalities need to capture their monitoring data and record it to allow for these checks in the future.

20. Still confusion about aquitards (c. 6)
SOW suggested that the WSMP characterization and description relating to aquitards should be consistent with the Tier 3 characterization. Matrix noted they will work with Township to ensure that this is consistent.

21. Error on Table 3 (c. 17)
Matrix acknowledged this error and will correct it.

Other questions and comments
There was in inquiry as to whether there is a boundary for the use of the model under current calibrations (e.g. do the models still apply if water use is doubled?) and at what point the model would need to be recalibrated based on the addition of new wells. Matrix responded that there is a capacity at which, if one tried to pump the wells, the model identifies that one can't obtain the amount of water that is desired from the current configuration. Matrix further responded that the system is fairly linear (if pumping is doubled, drawdown is approximately doubled); therefore, the projections are considered to be fairly good quality. What changes is how long it will take for

water to move through the system (e.g. it can take a long time for water to move up from groundwater features).

Meeting Outcomes

The following list details how the draft Groundwater Model Development and Calibration Report will be updated based on the discussion provided in the meeting summary below.

- Edit draft Groundwater Flow Model Development and Calibration Report to incorporate the following:
  - Remove references to lengths of time such as long-term
  - The value of 251 litres per day per household provided on page 19 of the draft Groundwater Modelling report is a typo. This will be revised to state 251 litres per day per person. The value of 251 litres per day per person is employed in the groundwater model.
  - Type of Table 3, page 18 of the report which lists the average annual consumptive rate of municipal well E3 as 249 m^3/day which is a type. This volume should be 569 m3/day and will updated in the table.

Next Steps

The GRCA will publish a summary of the meeting to the project web page; this will close the comments from the CLG meeting in May. Matrix will finalize the groundwater model development and calibration report and move onto completing the uncertainty and risk assessment.

Appendix A – Agenda

Centre Wellington Scoped Tier 3 Water Budget Study: Discussion on draft Groundwater Flow Model Development and Calibration Report

Location: Grand River Conservation Authority Head Office, Cambridge
Date: September 27, 2018
Time: 10:00am to Noon

Invited Participants:

Community Liaison Group Public Representative	Ministry of Environment, Conservation and Parks
Grand River Conservation Authority	Save Our Water
Lura Consulting	Township of Centre Wellington
Matrix Solutions Incorporated	Wellington Source Protection

Meeting Objective: To review and discuss comments provided by Save Our Water on the draft Groundwater Flow Model Development and Calibration Report.

Agenda:

1. Introductions
2. Short-term project (c. 1)
3. How will future water-taking be balanced? (c. 10)
4. How can ecological impacts be assessed? (c. 11)
5. Conforming to provincial wetland strategy (c. 15)
6. What portion of the 6% is available to the Township's wellfield (c. 8)
7. Not all of the water available to Centre Wellington's municipal wells is usable (c. 18)
8. Impact of Middlebrook should be assessed with all aspects of the Tier 3 (c. 3)
9. Groundwater infiltration to Fergus sewer system (Additional question Sept. 22)
10. Total demand from households on private wells is low (c. 18)
11. Groundwater boundary flow (c. 9)
12. Future land uses within the study area (c. 4)
13. Private well residences becoming serviced (Additional question Sept. 22)
14. Please explain the 98% (c. 7)
15. The study does not assess the sustainability of the aquifer (c. 2)
16. Groundwater model needs regular updates (c. 5)
17. Uncertainties and the risk scenario assessment (c. 14)
18. When will the uncertainty assessment be undertaken? (c. 13)
19. Data gap regarding recharge rate through the Tavistock Till (c. 12)
20. Verifying accuracy (c. 19)
21. Still confusion about aquitards (c. 6)
22. Error on Table 3 (c. 17)

Appendix B: Comments Provided by Save Our Water

Centre Wellington Scoped Tier 3 Water Budget Assessment

Questions and Comments related to the Groundwater Flow Model Development and Calibration Report

1. ***This is a short-term project.*** The introductory paragraph of the Executive Summary states this project was initiated "to evaluate the long-term sustainability of the municipal water supply systems in Fergus and Elora". The statement is repeated on p. v. It would be preferable to define this as a 'short-term' project following GRCA terminology.

The Grand River Watershed Management Plan: *Water Demand Management: Meeting Water Needs in the Grand River Watershed*, prepared by James Etienne and the GRCA, define 'short-term' water management as a 20-25-year horizon. The document recommends a 25 to 50- year planning horizon for water management, stating "this is particularly important for land-locked communities relying on local groundwater supplies." (Appendix B, p. 3, 2014).

According to the GRCA's criteria, the Scoped Tier 3 and the Water Supply Master Plan, both with horizons to 2041, or 23 years, would be considered 'short-term' water management.

The Model Report explains on p. 1 that risk scenarios reliant on the yet-to-be-determined growth targets and densities cannot be evaluated at this time beyond the year 2031, making this, in fact, a mere 13-year assessment horizon. The density requirement, and the recharge numbers calculated from that requirement, are critical factors without which the other assessments could not be valid, and certainly not 'long-term'. Additional scenario limitations at his current time relate to the township not having a 20-year water-services plan locked into its Official Plan.

Also, the study does not assess the sustainability of the 'water system', as infrastructure is the mandate of the Water Supply Master Plan. The study in hand concerns sources.

2. ***The study does not assess the sustainability of the aquifer.*** Related to the above statement, our concern is that it is not made clear that the Tier 3 studies do not assess the sustainability of the large regional aquifer.

3. ***Impact of Middlebrook should be assed with all aspects of the Tier 3.*** Figure 13d identifies the observed drawdown impact at the Middlebrook Well during Elora and Fergus municipal well pumping tests. These results indicate a connection between all of these wells. Given this connection, will the tests combine Middlebrook Well's daily pumping along with the municipal wells? If not, why not given its proposed daily extraction rate is equivalent to almost three of Centre Wellington's municipal wells?

4. ***Future land uses within the study area.*** To what extent will future developments in businesses such as the aggregate industry, farm businesses, golf courses, and recreational

facilities influence recharge and water demand amounts? How are these future non-municipal land uses calculated in the water budget? Now that the study has established the baseline conditions, would the study please add to the report these assumptions related to future water demand and recharge.

5. ***Groundwater flow models need regular updates.*** At the May 15 CLG meeting, Matrix acknowledged that models need to be opened up and updated with current information every 5 to 10 years. What plans are in place with the Township of Centre Wellington for this to happen?

Ideally, upon completion of the current project, the model should continue to be used to assess future proposed water and land uses (e.g., aggregate industry, farm businesses, golf courses, recreational facilities and industry) against the established baseline conditions. The desired intent is to assist municipal officials to make informed long-term water management decisions involving assessing land use planning applications as they are presented. We should not be waiting 5 to 10 years, especially given the suggested fragility of our water resource.

6. ***Still confusion about aquitards.*** The Water Supply Master Plan interim status report of June 13 describes the aquitards protecting the Fergus Elora Water Supply System as follows: "Bedrock units that behave as aquitards between the aquifer units include the Vinemount Member of the Eramosa Formation and, in places, the Reformatory Quarry Member and the Cabot Head Formation." (page 4, Technical Memorandum 2)

Since the Vinemout Member is not identified anywhere near Fergus and Elora, the Reformatory Quarry Member exists only east of Fergus, and the Cabot Head is the basement floor underneath all the aquifers, the WSMP team also assumes, as Save Our Water did, that no aquitards exist to protect the Fergus and Elora well water supplies.

Would Matrix please explain to the WSMP team that with the flow model report Matrix is now suggesting "the upper portion of the Guelph Formation is a competent aquitard that limits the connection between the shallow overburden aquifers and deeper municipal bedrock aquifers." (page 33) This is significant new information for the Water Supply Master Plan analysis, and the WSMP should now be edited to reflect this.

7. ***Please explain the 98%.*** The modelling report states that 98% of the water is recharged locally. What is the evidence to support this statement? Also, given that water in aquifers moves generally laterally, while water in aquitards moves generally vertically, and that the water in the deep bedrock could be up to 50 to 500 years old, does this imply that much of the bedrock in the study area would be identified more as aquitard than aquifer?

8. ***What portion of the 6% is available to the Township's wellfield?*** The assessment concludes that of the total water entering the study area 6% reaches the lower bedrock aquifer. Given the size of the study area, the flow direction of water in the lower aquifer, the unequal recharge and the locations of the higher recharge areas with the large area of high recharge in the Speed river sub watershed, what portion of this 6% would be available to the Township's municipal wellfield?

9. ***Groundwater boundary flow.*** Figure 4 shows no groundwater cross-boundary flow to the east, even though the flow of water from this part of the boundary is to the east toward Guelph Lake. Could you please explain?

10. ***How will future water-taking be balanced?*** What is the source of water to replace future large-scale municipal and potential commercial groundwater extraction from the lower bedrock aquifer? Is it coming from an increase in recharge from the overburden and upper bedrock aquifers, from a decrease in the flow of water out of the study area, from increased inflow from outside the study area, from the 2% discharged into rivers, streams and wetlands, or from the water that's stored in the aquitards and aquifers right now? Assuming more than one source, what combination and in what proportions of these sources would you expect this influx of water to balance that being removed? How does the relatively slow movement of water in the lower bedrock aquifer factor into this?

11. ***How can ecological impacts be assessed?*** Over a long period of time, how much of this increased extraction from the lower bedrock aquifer would be balanced by decreased output from the overburden and upper bedrock aquifers into rivers, streams and wetlands? Given that impacts would be expected to be incremental but cumulative, diffuse, spread over a very wide area and almost impossible to measure, how can these impacts be assessed?

12. ***Data gap regarding recharge rate through the Tavistock Till.*** On page 47, the authors mention the groundwater recharge rate through the Tavistock Till in the northeastern portion of the model represents an important knowledge gap. How might we close this gap?

13. ***When will the uncertainty assessment be undertaken?*** Page 45 mentions "uncertainties are typically evaluated through uncertainty assessment." At what point in the process will this uncertainty assessment be undertaken and will the results be included in the report?

14. ***Uncertainties and the risk scenario assessment.*** Given the high level and number of uncertainties in data from lack of good well information, will the risk scenario assessment take a conservative approach?

15. ***Conforming to provincial wetland strategy.*** The model will be used to assess impacts on cold water streams and Provincially Significant Wetlands (p. 1). Why is the study not assessing impacts to all streams and creeks and rivers and all wetlands? The province of Ontario's wetlands strategy: *A Wetland Conservation Strategy for Ontario 2017-2030*, provides Provincial policy with a focus on restoring wetlands across the province "to sustain biodiversity and to provide ecosystem services for present and future generations." With the loss of 70 - 80% of wetlands in the Grand River watershed, and a loss of 85% of wetlands throughout southern Ontario, should there be an aim with this Tier 3 to ensure that ALL wetlands are not only protected from any impacts but are in fact enhanced? Now that the value and function of these wetlands is better understood, is there not an obligation to *enhance* wetlands in a watershed that has lost the vast majority of its wetlands, as the MNRF advises?

Are you expecting that there will be data gaps related to any reduction in groundwater discharge to any wetlands? or gaps related to gradients within and surrounding wetlands or to the recharging or discharging nature of any wetlands seasonally or over time?

16. ***Total demand from households on private wells is low.*** The total demand from households on private wells is low as it is stated on page 19 at 251 l/day per household. The WSMP interim report states that the per capita use based on metered use is 155-165 l/day. With an average 2.5 persons per household (Stantec, 2016), this would be 432 l/day water demand per household.

Additionally, these per capita numbers do not take into account the municipal problem with the hardness of water impacting water meters, causing them not to record accurately. Consequently, per person daily water use is underestimated. Adjusting the number closer to an Ontario municipal average would be more representative of actual use.

The WSMP interim report Memorandum 1, p. 2 now identifies 3,509 residents within Fergus and Elora in unserviced homes. This increased number is from households that opted out of municipal water in serviced areas. This now represents 1 in 7 urban residents using private wells.

17. ***Error on Table 3.*** There is an error in Table 3, page 18 of the report, which lists the average annual consumptive rate of municipal well E3 as 249m3/day. This volume should be 569 m3/day.

18. ***Not all of the water available to Centre Wellington's municipal wells is usable.*** When the Tier 3 team presented the modelling report to council, a councilor asked about the quality of water at several Fergus wells. This was a good question. Of course, as has been already explained, this question is outside the scope of the Tier 3. But we would like to see a response to these kinds of questions that accepts that there are facts that cannot be addressed by Source Protection Zones, as is consistently the answer. Factors related to the nature of the bedrock itself such as excessive hardness, sulphates, high TDS, and also contamination that has not yet been tracked in the bedrock, are issues that cannot be addressed by a line on a map in the Planning Department. We would like it acknowledged that not all of the water that is available is actually going to be usable.

Case in point. Elmira is known for its polluted groundwater that is not fit to use. If you were conducting a Tier 3 study of Elmira's water supply, excluding water from Waterloo and all other regions, would you conclude that they have an abundant water supply or none whatsoever?

19. ***Verifying accuracy.*** What is your due diligence process to verify the accuracy of your modelling results? Will the modelling results be verified with observations from local water monitoring?

Appendix C: List of Participants

Community Liaison Group Public Representative
- Tom Nudds

Grand River Conservation Authority (GRCA)
- Martin Keller
- Sonja Strynatka

Lura Consulting
- Alex Lavasidis

Matrix Solutions Incorporated
- Christian Gabriel
- David Van Vliet

Ministry of Environment, Conservation and Parks (MECP)
- Kathryn Baker

Save Our Water (SOW)
- Dave Blacklock
- Donna McCaw
- Ian MacRae
- Jan Beveridge
- Jim Wilton

Township of Centre Wellington
- Colin Baker

Wellington Source Protection
- Emily Vandermeulen
- Kyle Davis

Centre Wellington Tier 3 Water Budget Assessment
Community Liaison Group Meeting #4

Monday, November 18, 2019
7:00 – 8:40 pm
Aboyne Hall, Wellington County Museum
536 Wellington County Rd 18, Fergus

Meeting Summary

Welcome, Agenda Review, and Introductions

Mr. Jim Faught, Director, Community Engagement with LURA Consulting, welcomed attendees to the meeting and introduced himself as the neutral, third-party meeting facilitator and Mr. Amitai Zand, Community Engagement Coordinator with LURA Consulting, as the note taker. Mr. Faught reminded attendees of the purpose of the night's fourth Community Liaison Group (CLG) meeting, which was to provide a refresh of the Centre Wellington Tier 3 Water Budget Study process, scope and key participants, and to provide an overview of the results of the recently completed Risk Assessment Report. He also reviewed the mandate of the CLG and the group's code of conduct and terms of reference (available on the project website). Mr. Faught clarified that members of the public in attendance who were not members of the CLG were welcome to participate in the meeting in an observational capacity only.

Mr. Faught provided an overview of the meeting's agenda. The agenda can be found in Appendix A of this summary.

Mr. Faught led a round of project team member and CLG member introductions. The list of project team members and CLG members in attendance can be found in Appendix B of this summary.

Presentations

Four presentations were given: a project context update and a review of the Tier 3 process, a review of the groundwater flow model, an update on the Township's Water Supply Master Plan (WSMP), and a presentation of the risk assessment results. A combined copy of all four presentations is available on the project website.

(1) Project Context Update and Review of the Tier 3 Study Process
Martin Keller, Lake Erie Region Source Protection Program Manager

Mr. Martin Keller began by updating attendees that the Ontario provincial government announced today a proposal to extend the current moratorium on new water bottling permits for nine more months, until October 1, 2020.

Mr. Keller informed attendees that the Province has completed a review of policies, programs, and science for its Water Quantity Strategy.

Mr. Keller provided updates on the Middlebrook Well, owned by Nestle Waters Canada. He noted that the well was incorporated into the groundwater model but not a part of the Tier 3 Risk Assessment. The Risk Assessment recommends a more fulsome evaluation of the Middlebrook Well for future water taking, as currently there is a lack of local information about the well, and water taking from the well is not currently permitted through the provincial Permit to Take Water (PTTW) program.

Mr. Keller explained that the PTTW program entails a review of site-specific assessments of impacts to other water takings and the natural environment.

Mr. Keller provided an overview of the Tier 3 study components and where the study fits within the current system of regulatory processes (e.g. PTTW, the Safe Drinking Water Act, WSMP, Provincial Policy Statement, and Environmental Assessments).

Mr. Keller concluded his presentation with an overview of the CLG input and peer review process.

(2) Groundwater Flow Modeling Review

David Van Vliet, Vice President, Technical Practice Areas, Matrix Solutions Inc.

Mr. David Van Vliet began by presenting a timeline of the Tier 3 study with major report milestones:

- Late 2017: Characterization report
- Early 2019: Model report
- Now: Risk assessment report
- Next: Policy development

Mr. Van Vliet gave an overview of the geographic study area for the project, the background review, and the project's various data inputs. He then explained how groundwater flow can be interpreted using the provincial domestic well database and other high quality well data, showing a map of groundwater flow in and around the Centre Wellington area, with much of the flow moving south towards the Grand River and other coldwater streams, with some removal by groundwater wells along the way.

Mr. Van Vliet presented a pie chart showing estimated groundwater demands in the area, proportionally by user type, and then showed a map of water well monitoring locations in the area.

Mr. Van Vliet presented an overview of how groundwater models are developed, what they are, and how they are used. He explained that they mimic real-life circumstances that cannot be tested in the field, in order to answer "what if" questions of groundwater flow and supply. He continued by explaining

how characterization (geological interpretations, layer property interpretations, and water demand/water level data) contributes to the groundwater flow model, and how the model is calibrated. As an example, he noted that a municipal well shutdown test in 2012 provided information to help calibrate the Centre Wellington groundwater flow model, acknowledging however that uncertainty in the model grows further outside the Township's serviced area where the availability of high quality data decreases.

Mr. Van Vliet guided attendees through an animation of the groundwater flow model for Centre Wellington showing a cut out of the local geological layers and hydraulic conductivity.

Mr. Van Vliet concluded his presentation with a review of what a water budget is (i.e. a quantification of water flow inputs [sources] and outputs [uses]).

(3) Centre Wellington Water Supply Master Plan (WSMP) Update

Colin Baker, Managing Director of Infrastructure Services, Township of Centre Wellington

Mr. Colin Baker updated attendees on the status of the Township's Water Supply Master Plan. Local council approved the WSMP in June, 2019 and the Township has filed a notice of completion with the province. The WSMP indicates that the serviced population of Centre Wellington is projected to double by 2041. Mr. Baker presented a graph of the average and maximum day demand for water in Centre Wellington and noted that the WSMP determined that the municipality would require a new water supply source before 2031.

Mr. Baker remarked that Phase 2 of the WSMP involves developing and evaluating alternatives, identifying and mitigating impacts, and developing an implementation strategy. He also noted that the WSMP recommends that some Centre Wellington wells be deepened, and that new water sources must be identified.

Mr. Faught asked attendees if they had any questions of clarification so far. They had none.

---

(4) Presentation of Risk Assessment Results

David Van Vliet, Vice President, Technical Practice Areas, Matrix Solutions Inc.

Mr. David Van Vliet presented an overview of the Tier 3 Risk Assessment (RA). He noted that the province lays out specific steps that must be followed to complete an RA.

He explained that an RA evaluates a number of "what if" scenarios that could impact the local water supply, such as current demand, drought, projected population growth, increased development, etc. He noted that groundwater recharge decreases with increased paved development, and to illustrate, presented Centre Wellington's Official Plan map with areas slated for redevelopment highlighted. Mr. Van Vliet presented a scenario matrix, saying that Centre Wellington's water demand can successfully be met until 2031 under multiple scenarios barring any unforeseen issues. Past 2031, however, a new water source will need to be found to meet demand since the current well infrastructure capacity cannot sufficiently meet the projected average day demand in 2041, representing a significant level of risk to local water security.

Mr. Van Vliet gave an overview of a municipal well diagram, explaining that numerical model scenarios are run, and if water falls below the safe operating level of the well, then water demand will not be met, or the well may not operate reliably.

Mr. Van Vliet showed a map of coldwater streams and wetlands in and around Centre Wellington, as well as a map from the RA showing the delineation of Centre Welligton's Vulnerable Area with the drawdown cones within it. He explained that drawdown cones form when water is extracted by a well. As the water is withdrawn, the water table's elevation decreases in the shape of a cone. Mr. Van Vliet explained that multiple wells, increased rates of pumping, and proximity to other water takings increase the size of drawdown cones and may affect nearby cones. . Mr. Van Vliet noted that although water takings and future developments within the Vulnerable Area do not necessarily affect the municipal water supply, the Vulnerable Area is assigned a significant risk level and all groundwater takings and potential groundwater recharge reductions within it is classified as significant water quantity threats.

An attendee asked Mr. Van Vliet to clarify whether the RA was part of a Risk Management Measures Evaluation Process (RMMEP), and Mr. Van Vliet responded affirmatively.

Mr. Van Vliet presented a map of water quantity threats in the Vulnerable Area and a number of insights gained from the RA, including (among other insights) the conclusion that unserviced domestic water well pumping, as well as other existing water uses like livestock watering, only minimally or negligibly affect Centre Wellington's water supply aquifer. He also gave an overview of the Tier 3 study's peer review process and peer review committee, and how they ensure that the Tier 3 water study work is scientifically defensible.

Facilitated Discussion

Questions of Clarification

A summary of the questions of clarification is provided below. Questions are noted with **Q** and responses are noted by **A**. Please note this is not a verbatim summary.

CLG members were given the opportunity to ask questions and share comments or concerns relating to the risk assessment report.

Q. Was the Vulnerable Area assessed to 2031? Will it become wider and deeper in the future?
A. Yes, it was, using the 2031 projected municipal water pumping rate. The delineation of the vulnerable area is not expected to change significantly in the future but could change in shape with the additional of new or private permitted takings. The municipal wells will have minimal impact on the shallow system.

Q. What impact does the Vulnerable Area have on other uses like private wells? How will the municipal water system affect private unserviced supply and deep livestock watering wells?
A. Most agricultural wells interact with water above the aquitard. Increased pumping has a very minimal impact to shallow water levels or ecological features. If the livestock wells are deep and further from the municipality, they will not have a significant impact on municipal well water levels. Aquaculture wells, for example, have a high pumping rate and this does affect overall water levels in the aquifer, but it does not translate to impacts to municipal well water levels.

Q. Given the amount of uncertainty and data gaps, how confident are you in the delineations of the vulnerable areas?
A. The closer to the service area/municipal area, the higher the confidence. Everything we know about the Gasport Aquifer implies a larger area. Leakage rates can affect the delineations.

Q. As you collect more data, could you refine the vulnerable area delineations?
A. The municipality can re-run the scenarios to see if the delineations change.

Q. Pump tests yield a lot of data, but could the township not conduct its pump tests first? Which pump test would come first?
A. There is no set sequence for this, but as we look at new areas for water supply, there would be a process to update this work and the model. It is legislated under the Clean Water Act that we need to update the vulnerable area delineations before doing that.

Q. I have been impressed with what I have seen in the Tier 3 work so far. The work is very thorough despite the uncertainties. Will the transparency continue going forward with stakeholder engagement? It is important to me that the process and data are transparent and accountable.
Thank you for the kind words, but it is a question we will need to ask ourselves going forward. Eventually there will be new information available, and at that time we will be talking to the township about the process. It may not look the same as the Tier 3 process, but we will explore ways to maintain the engagement. Further, more formal engagement will take place with the Source Protection Committee before we can submit the entire product to the province.

Q. Does the model take into account any growth in aquaculture uses?
A. No, it does not. In other Tier 3 studies in the province, however, we have looked at how changes in uses could impact the municipality's water supply. That said, if you were to redo the Tier 3 here after a number of years, you may see changes in uses. If new uses are introduced in this area, policy could call for running the model again. You would have to look at it on a case-by-case basis. There is no process for changes for non-municipal water uses, although there is for municipal uses (e.g. official plan, land use and development targets).

Q. The Vulnerable Area Delineation map looks to me like a bucket of water. Each area within the map has different water conductivity rates. The municipality has identified future well sites with good conductivity rates. Once you have identified the best municipal well sites, should those areas be granted special protections, standards, and policies? Because some areas are more ideal for taking water than others and should be protected.

A. The idea of the vulnerable area is to map out an area to protect and further study water takings within that area. There are wells that are highly productive and areas that are not, so testing is important, but viability of individual wells are not guaranteed so it is difficult to protect them for that reason. The uncertainty of current data does not make it feasible to subdivide the vulnerable areas into smaller areas and protect some but not others. The larger area does not experience impacts universally the same across the whole area, but insights from this stage of the study will translate into policy development that addresses changes across the whole vulnerable area. The AECOM map shows ideal scenarios and locations for future wells based on these ideal scenarios. But the underlying geology of installing pumping wells at these locations is unknown, and so are effects of those individual future wells on water supply. We would need more studies, testing and data to be able to subdivide the WHPA into areas that would need to be protected, however, this takes a lot of time and money and is not currently feasible as we cannot protect something that isn't certain.

Q. With the boundaries of your modelling study, the boundaries for drought surprise me. They are relatively limited and based on the facts you have. But considering what is happening with droughts in California and Australia, no one thought there would be major droughts there but now there are. If in 2035 there is a major drought here, what security is there for the local water supply?

A: Climate change assessment and drought assessment do address the risk due to major droughts and climate change. There was a period in the 1960s when there were significant drought conditions here in Centre Wellington. We run models using the 1960s drought experience see how the municipal water supply would respond to those conditions if the drought reoccurred. In this part of the world (Southern Ontario), the general effects projecting from climate change is wetter, warmer winters. This will result in greater groundwater recharge, so our groundwater supplies may not be adversely affected by climate change. We feel therefore that Centre Wellington's water supply is more resilient to climate change as compared to other areas of the world.

Q. Are you making assumptions that current climate change predictions from today will hold for all of the next 25 years?

A: We are making the assumption that the current climate change projections are the best estimate at this point in time to predict climate change effects on our water supply over the next 25 years. Climate change projections are updated approximately every 5 years and we always recommend updating our effects modelling as new data becomes available.

Q. What about the precautionary principle? Does it figure in the policy framework? Decision makers have different levels of risk aversion when it comes to making policy.

A. The Water Supply Master Plan does use that principle when we theoretically take the largest well offline during modelling. This ensures that we plan for a resilient supply under multiple scenarios.

Q. Is there consideration for potential contamination in the modelling?
A. No, not in the quantity assessment. That is a separate process: There is a whole other side of the source protection program that focuses on quality and evaluates the impact of contamination on municipal wells.

Q. Has the preferred strategy been published yet?
A. Yes, the report is public. Deepening some of the wells (F2 and F5) and optimizing others is one of the recommendations from the assessment. Water conservation measures are also part of the WSMP recommendations. These are in addition to exploration for new groundwater sources. The Water Supply Master Plan is available to view on the Centre Wellington website.

Q. Who would pay for a study on contaminant flow/transport? Climate change was not included in this assessment, the report says, only drought. Is the ministry going to keep funding the Tier Three and other needed work? There is more to study but the funding seems to be running out.
A. Contaminant flow and transport is not within the scope of the Tier 3 and we need to be careful about the scale of these studies. The scale of the Tier 3 is quite large, and the scale needed to assess local contamination issues is quite small. We are fairly close to having completed the climate change component of this study and this will be published separately.
In addition to the Tier 3, the municipality will always continue its work to secure a long-term reliable water supply. Much of the township's work is to service growth, and these studies, such as the WSMP, are funded by the growth itself through development charges.

Contaminated sites are being monitored but it is the MECP responsibility. They have offsite assessments and hydrogeological studies which are not always made public. The contaminated sites is a process carried out by the MECP, not by the Township.

Q. Would Tier 3 do the groundwater contamination modelling? Who will do it?
A. The MECP (Ministry of Environment, Conservation and Parks) through legislation requires the identification, monitoring and clean-up of potential contamination sites.

Q. Is this work part of the off-site assessment and monitoring?
A. It is out of scope of the Tier 3 study. A site-specific contamination or contaminant fate and transport assessment is totally different from this water quantity assessment. Insights from each can certainly inform the other, but they are separate processes.

Q. Will the policies coming out of the Tier 3 study be approved when the moratorium ends? Why the October 2020 date for the moratorium?
A. The moratorium is under the province's purview, but we will not have approved policies before the moratorium expires. The October public consultation period has no connection to the proposed end date for the moratorium.

Q. Is there an opportunity for additional input or review of the risk assessment?
A. You will have two weeks from the release of the meeting notes to comment, which will be within two weeks from today.

Next Steps and Adjournment

Mr. Keller confirmed with CLG members that they should provide any additional comments or questions regarding the Risk Assessment and Report within two weeks by December 6, 2019. He explained that these comments will be summarized and posted on the project website. Mr. Keller stated that presentations from the meeting will be posted on the project website. Mr. Keller explained that the next steps include the project team developing draft policies using the insights from the Tier 3 study process to date. The draft policies will be presented to CLG members for feedback at the next CLG meeting. The date for the next CLG meeting is to be determined but will likely occur in February or March 2020.

Mr. Faught and Mr. Keller thanked CLG members for contributing to the discussion and adjourned the meeting.

Appendix A – Agenda

Centre Wellington Tier 3 Water Budget Study

Community Liaison Group Meeting #4
Monday, November 18, 2019
7:00 – 9:00 pm
Aboyne Hall, Wellington County Museum

***Meeting Purpose**:*

1) Provide a refresh of the study process, scope and key participants;
2) Provide an overview of the water budget and risk assessment process;
3) Receive feedback on the Risk Assessment Report; and
4) Address any questions about the process overall.

AGENDA

7:00 pm	**Welcome** Jim Faught, Facilitator, Lura Consulting
7:05 pm	**Introductions and Updates** Martin Keller, Lake Erie Source Protection Region
7:15 pm	**Review Summary** David Van Vliet, Matrix Solutions Inc., and Colin Baker, Township of Centre Wellington
7:25 pm	**Water Budget Review** David Van Vliet
7:40 pm	**Risk Assessment** David Van Vliet
8:00 pm	**Discussion and Feedback** • ***What did you like or confirmed your thinking in the Risk Assessment Report?*** • ***Was there anything surprising or concerning in the Risk Assessment Report?*** • ***Any other comments?***
8:30 pm	**Next Steps and Wrap Up** Martin Keller and Jim Faught
8:40 pm	**Adjourn**

Appendix B – List of Attendees

A. Community Liaison Group Members Present

Member	Organization
Andreanne Simard	Nestlé Waters Canada
Dave Blacklock	Wellington Water Watchers
Derek Graham	Chamber of Commerce
Jan Beveridge	Save Our Water
Jim Wilton	Save Our Water (alternate member)
Colin Richardson	Public Interest
Tom Nudds	Public Interest

B. Project Team Members Present

Core Team	Support Team	Organization
Martin Keller Sonja Strynatka		Grand River Conservation Authority
David Van Vliet	Jeff Melchin Christian Gabriel	Matrix Solutions Inc.
Kyle Davis	Emily Vandermeulen	Wellington Source Water Protection
Colin Baker	Courtney Fish	Township of Centre Wellington
Jim Faught	Amitai Zand	Lura Consulting
Kathryn Baker		Ministry of Environment, Conservation and Parks

In addition to the participants listed above, 5 observers were in attendance at the meeting including members of the public and Ian MacRae and Neil Dunsmore, two councillors for the Township of Centre Wellington.

December 6, 2019

Martin Keller
Source Protection Program Manager
400 Clyde Road
Cambridge ON
N1R 5W6
E-mail: mkeller@grandriver.ca

Comments on the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report

Dear Martin:

Nestlé Water Canada (NWC) has reviewed the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report prepared by Matrix Solutions Inc. for the Grand River Conservation Authority, dated November 2019 and are providing the following comments.

1. NWC concurs with the acknowledgement in Recommendation #1b that the simulation of drawdown at the Middlebrook Well due to pumping from that well is uncertain. The collection of additional data from focused additional field-based investigations is essential to reduce the uncertainty to a level such that any predictions of potential long-term effects of pumping from the Middlebrook well might be considered scientifically defensible.

2. NWC supports recommendation #1b to collect additional local high-quality data and to complete an aquifer pumping test in the area. In particular, it will be necessary to conduct investigations to assess the hydraulic properties of the bedrock aquifers between the Middlebrook well and the existing municipal supply wells, and to evaluate the potential for developing groundwater supplies at proposed locations for new municipal supply wells. The investigations must include long-term pumping tests.

3. NWC suggests that the statement on Page 23 of the draft final report be amended slightly. The statement currently reads, “As such, additional data collection, characterization, and calibration of the model may be required if predictions are required in areas that lie outside the focus area of this study, including in the vicinity of the Middlebrook well.” The statement should read, “As such, additional data collection, characterization, and calibration of the model is required if predictions are required in areas that lie outside the focus area of this study, including in the vicinity of the Middlebrook well.”

4. In a memorandum transmitted to the Grand River Conservation Authority on August 28, 2019, S.S. Papadopulos & Associates, Inc. compiled several detailed lines of evidence leading to the conclusion that the groundwater model developed for the Centre Wellington Tier Three Water Budget Study was not fit for the purpose of making predictions of potential effects of pumping the Middlebrook well on hypothetical additional municipal supply wells. Despite the limitations of the groundwater model, it was applied for this purpose in the preparation of the Centre Wellington Water Supply Master Plan (page 81 of the draft dated July 2019). No discussion of the uncertainties in the predictions was presented in the Centre Wellington Water Supply Master Plan report, nor was there any assessment of the consistency of the model results with

long-term testing and monitoring data from the Middlebrook site. No data are available to confirm the assumed subsurface properties at the locations of the hypothetical additional municipal wells, or between these wells and the Middlebrook well. The predictions of the potential effects of possible pumping from the Middlebrook on hypothetical additional municipal wells are highly speculative. Under no circumstances should the reported impacts of pumping from the Middlebrook wells on potential future municipal wells be regarded as factual.

5. It was indicated during the Community Liaison Group meeting #4 (November 19, 2019) that the peer review panel concluded that "the Risk Assessment is scientifically defensible and that the deliverables are consistent with the province's source protection framework". The peer review record was not included in the draft final Risk Assessment report (version 0.4, November 2019). Will the peer review comments and the responses to the comments be included as an appendix to the final version of the Risk Assessment Report? It is also our understanding that geology and groundwater experts with the Ontario Ministry of Natural Resources (Ontario Geological Survey) and the Ministry of the Environment, Conservation and Parks provided comments on the development of the Tier Three groundwater model. Will their comments and the responses to them be included in a publicly accessible peer review record?

6. During the Community Liaison Group meeting #4, in response to the question on how much confidence can be assigned to the delineation of the "vulnerable area" (that is, the WHPA Q1), David Van Vliet of Matrix Solutions responded that the WHPA-Q1 is "not something that you can measure." The methodology for the delineation of the WHPA Q1 is described on Page 24 of the Risk Assessment Report. However, there is no discussion of the uncertainty inherent in the delineation. For example, there is no discussion of the accuracy of the model calculations of groundwater levels relative to the 2.0 m drawdown contour adopted as the boundary of the WHPA Q1. Furthermore, there is no discussion regarding how the limits of the WHPA Q1 might change if different flow rates are assumed across the model boundaries (Figures 5, 19b and 19c of the Tier Three Model Development and Calibration Report, Version 1.0).

Please let me know if you have any questions or require further clarification. We look forward to your written response.

Sincerely,

Andreanne Simard, Ph.D.
Natural Resource Manager

Version 1.0
March 11, 2020 Matrix 23876-527

Ms. Sonja Strynatka
GRAND RIVER CONSERVATION AUTHORITY
400 Clyde Rd.
Cambridge, ON N1R 5W6

Subject: Response to Nestlé Waters Canada Comments on the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report

Dear Ms. Strynatka:

The purpose of this letter is to provide a response to Community Liaison Group (CLG) comments received from Nestlé Waters Canada (NWC) dated December 6, 2019 regarding the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report (Tier Three Assessment; Matrix 2019).

1 RESPONSE TO SPECIFIC COMMENTS

1. Comment: *NWC concurs with the acknowledgement in Recommendation #1b that the simulation of drawdown at the Middlebrook Well due to pumping from that well is uncertain. The collection of additional data from focused additional field-based investigations is essential to reduce the uncertainty to a level such that any predictions of potential long-term effects of pumping from the Middlebrook well might be considered scientifically defensible.*

   Response: Comment noted.

2. Comment: *NWC supports recommendation #1b to collect additional local high-quality data and to complete an aquifer pumping test in the area. In particular, it will be necessary to conduct investigations to assess the hydraulic properties of the bedrock aquifers between the Middlebrook well and the existing municipal supply wells, and to evaluate the potential for developing groundwater supplies at proposed locations for new municipal supply wells. The investigations must include long-term pumping tests.*

   Response: Comment noted.

3. Comment: *NWC suggests that the statement on Page 23 of the draft final report be amended slightly. The statement currently reads, "As such, additional data collection, characterization, and calibration of the model may be required if predictions are required in areas that lie outside the focus area of this study, including in the vicinity of the Middlebrook well." The statement should read, "As such, additional data collection, characterization, and calibration of the model is required if predictions are required in areas that lie outside the focus area of this study, including in the vicinity of the Middlebrook well."*

   Response: Agreed. The text has been revised as suggested.

4. Comment: *In a memorandum transmitted to the Grand River Conservation Authority on August 28, 2019, S.S. Papadopulos & Associates, Inc. compiled several detailed lines of evidence leading to the conclusion that the groundwater model developed for the Centre Wellington Tier Three Water Budget Study was not fit for the purpose of making predictions of potential effects of pumping the Middlebrook well on hypothetical additional municipal supply wells. Despite the limitations of the groundwater model, it was applied for this purpose in the preparation of the Centre Wellington Water Supply Master Plan (page 81 of the draft dated July 2019). No discussion of the uncertainties in the predictions was presented in the Centre Wellington Water Supply Master Plan report, nor was there any assessment of the consistency of the model results with long-term testing and monitoring data from the Middlebrook site. No data are available to confirm the assumed subsurface properties at the locations of the hypothetical additional municipal wells, or between these wells and the Middlebrook well. The predictions of the potential effects of possible pumping from the Middlebrook on hypothetical additional municipal wells are highly speculative. Under no circumstances should the reported impacts of pumping from the Middlebrook wells on potential future municipal wells be regarded as factual.*

   Response: This comment specifically relates to the Township of Centre Wellington Water Supply Master Plan (WSMP; AECOM 2019) and not the Centre Wellington Risk Assessment Report (Matrix 2019). Matrix has responded to comments from S.S. Papadopulos & Associates, Inc. regarding the numerical modelling conducted in support of the WSMP as part of that separate project.

5. Comment: *It was indicated during the Community Liaison Group meeting #4 (November 19, 2019) that the peer review panel concluded that "the Risk Assessment is scientifically defensible and that the deliverables are consistent with the province's source protection framework". The peer review record was not included in the draft final Risk Assessment report (version 0.4, November 2019). Will the peer review comments and the responses to the comments be included as an appendix to the final version of the Risk Assessment Report? It is also our understanding that geology and groundwater experts with the Ontario Ministry of Natural Resources (Ontario Geological Survey) and the Ministry of the Environment, Conservation and Parks provided comments on the development of the Tier Three groundwater model. Will their comments and the responses to them be included in a publicly accessible peer review record?*

   Response: Peer review comments from the provincial peer reviewers, as well as from other parties including municipal reviewers; the Ministry of the Environment, Conservation and Parks; Ontario Geological Survey; and CLG will be provided in appendices of the final Risk Assessment report, along with responses from the Tier Three Assessment project team.

6. Comment: *During the Community Liaison Group meeting #4, in response to the question on how much confidence can be assigned to the delineation of the "vulnerable area" (that is, the WHPA Q1), David Van Vliet of Matrix Solutions responded that the WHPA-Q1 is "not something that you can measure." The methodology for the delineation of the WHPA Q1 is described on Page 24 of the Risk Assessment Report. However, there is no discussion of the uncertainty inherent in the delineation. For example, there is no discussion of the accuracy of the model calculations of groundwater levels relative to the 2.0 m drawdown contour adopted as the boundary of the WHPA Q1. Furthermore, there is no discussion regarding how the limits of the WHPA Q1 might change if different flow rates are assumed across the model boundaries (Figures 5, 19b and 19c of the Tier Three Model Development and Calibration Report, Version 1.0).*

Response: Indeed, the delineation of the WHPA-Q1 is something that cannot be measured in the field. The WHPA-Q1 is delineated based on the 2 m composite drawdown contour of a hypothetical situation where the Centre Wellington municipal wells pump at future (Allocated) rates and non-municipal wells pump at their current rates, versus a situation where there is no groundwater pumping in the study area (i.e., representing pre-groundwater pumping conditions).

An uncertainty analysis was completed as part of the model calibration exercise and used to inform the assessment of risk at the water supply wells. This included a series of scenarios designed to assess the range of uncertainty of the model parameters, boundary conditions, and conceptual model and an evaluation of the significance of that uncertainty on potential model results. However, there was not an assessment of the uncertainty analysis completed as to the location of the WHPA-Q1 boundary.

The WHPA-Q1 is intended as a conservative boundary to delineate areas where groundwater recharge could be reduced in the future and consumptive water takings that may have an effect on water levels at municipal wells. As described in the risk assessment report, the fact that a consumptive water taking is located within this boundary does not imply that that water taking has an effect on municipal water takings. The Tier Three Risk Assessment process recognizes this, and therefore has a follow-up task in the process to complete a water quantity threats ranking that prioritizes those consumptive water takings and areas where groundwater recharge may be reduced within the WHPA-Q1, which have the potential to effect water levels at municipal wells.

2 CLOSING

If you have any questions regarding this letter, please contact David Van Vliet by phone at 519.400.3186 or by email at dvanvliet@matrix-solutions.com.

Yours truly,

MATRIX SOLUTIONS INC.

Jeffrey Melchin, M.Sc., P.Geo.
Hydrogeologist

David Van Vliet, M.A.Sc., P.Eng.
Vice President, Technical Practice Areas

VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	07-Feb-2020	Draft	23876-527 NWC L 2020-02-07 draft V0.1.docx	Issued to client for review
V1.0	11-Mar-2020	Final	23876-527 NWC L 2020-03-11 final V1.0.docx	Issued to client

REFERENCES

AECOM Canada Ltd. (AECOM). 2019. 'Township of Centre Wellington, Water Supply Master Plan'. Draft prepared for The Township of Centre Wellington. Kitchener, Ontario`. July 2019.

Matrix Solutions Inc. (Matrix). 2019. 'Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report'. Version 0.4. Draft prepared for Grand River Conservation Authority. Guelph, Ontario. November 2019.

Centre Wellington Risk Assessment November, 2019: Comments and Suggestions

Jim Wilton, Elora, On, N0B1S0

This report has considerable information and analysis and provides much useful material for planning for a secure water supply for the municipal water system in Fergus and Elora. The report clearly shows the justification for a Significant Risk rating.

The report could, however, be improved by adding clarity to the recommendations and executive summary. One major clarification is that the risk assessment does not include analyses for the population increase to 2041 as given in the water supply master plan, but only to current and allocated uses. Known long-term risks due to population growth beyond current population levels are not included.

Another clarification needed is that the risk included for drought is strictly based on historical data and no consideration of possible future changes is considered. It should at least be stated in the executive summary that any risks associated with future climate changes are not considered in this analysis.

It would be most useful for further planning to note that the risk assessments associated with meeting municipal water needs do not consider agricultural needs. Even though the objective of the risk assessment relates to municipal water needs, there may well be interactions of water supplies for the municipal system with those for the agricultural community and the risks of those interactions should at least be recognized for township and county planning.

For planning purposes it would also be more appropriate to re-word the recommendations and executive summary (viii) to show the needs for additional information should begin with the municipality obtaining additional data in their establishment of additional wells to satisfy long-term needs, followed by a repeat of the risk analysis study. Subsequent to that, other potential permit applicants could provide additional data if seeking a permit.

There should be a statement in recommendations that there is a risk that the model parameters may have to be revised as water taking proceeds for the larger population sizes expected, with that increased water taking being long-term over many years, especially if taken to 2041 or beyond.

As a small point, is the number in Table 14 of Industrial-Other a misprint? If not, a comment on this amount of use would be appropriate.

Thank you for your consideration of these comments.

Jim Wilton

Version 1.0
March 11, 2020 Matrix 23876-527

Ms. Sonja Strynatka
GRAND RIVER CONSERVATION AUTHORITY
400 Clyde Rd.
Cambridge, ON N1R 5W6

Subject: Response to Jim Wilton (Save Our Water) Comments on the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report

Dear Ms. Strynatka:

The purpose of this letter is to provide a response to Community Liaison Group (CLG) comments received from Jim Wilton of Save Our Water received December 2, 2019 regarding the *Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report* (Tier Three Assessment; Matrix 2019).

1 RESPONSE TO SPECIFIC COMMENTS

1. Comment: *This report has considerable information and analysis and provides much useful material for planning for a secure water supply for the municipal water system in Fergus and Elora. The report clearly shows the justification for a Significant Risk rating.*

   Response: Thank you. Comment noted.

2. Comment: *The report could, however, be improved by adding clarity to the recommendations and executive summary. One major clarification is that the risk assessment does not include analyses for the population increase to 2041 as given in the water supply master plan, but only to current and allocated uses. Known long-term risks due to population growth beyond current population levels are not included.*

   Response: Additional text has been added to the Executive Summary and Conclusions sections of the Risk Assessment report clarifying that the Tier Three Assessment can only assess existing water supply wells or alternative wells that have already been tested and evaluated under a Master Plan or Class Environmental Assessment (EA) process. The existing municipal supply wells can only meet the municipality's average water demand until somewhere between 2031 and 2036. *The Township of Centre Wellington Water Supply Master Plan* (WSMP) evaluated alternatives to meet the 2041 population demand and outlined a process whereby the municipality will locate and test new water supply wells. However, the preliminary water supply alternatives considered in the WSMP cannot be assessed through the Tier Three Assessment until their respective sources are evaluated within a Master Plan or Class EA.

3. Comment: *Another clarification needed is that the risk included for drought is strictly based on historical data and no consideration of possible future changes is considered. It should at least be stated in the executive summary that any risks associated with future climate changes are not considered in this analysis.*

   Response: The potential effects of climate change are not evaluated as part of this Tier Three Assessment. However, these effects will be evaluated and documented in a subsequent report similar to the climate change study completed in support of the Guelph-Guelph Eramosa Water Quantity Policy Study (Matrix 2018). This is stated in Section 4.2 of the Risk Assessment report (Matrix 2019). Additional text has been added to the Executive Summary to this effect (pg. vii)

4. Comment: *It would be most useful for further planning to note that the risk assessments associated with meeting municipal water needs do not consider agricultural needs. Even though the objective of the risk assessment relates to municipal water needs, there may well be interactions of water supplies for the municipal system with those for the agricultural community and the risks of those interactions should at least be recognized for township and county planning.*

   Response: While the focus of the Tier Three Risk Assessment report is on the Centre Wellington municipal water supply system, groundwater takings associated with livestock watering have been represented in the groundwater flow model. The representation of the agricultural demands is summarized in Section 5.2.2.2 of the Risk Assessment Report:

   > *The Tier Three model includes agricultural water uses associated with livestock water demands within a 3 km buffer surrounding the Fergus and Elora municipal wells. Water takings associated with a large poultry operation located near Ponsonby, outside of the 3 km buffer, are included. In total, livestock demands are represented in the model using 36 pumping wells, with a combined estimated consumptive demand of 596 m^3/day.*

   As a result, the interactions between those takings and the municipal takings are represented in the model.

   Furthermore, the relative impact of livestock groundwater demands on the municipal wells has been evaluated as part of a preliminary water quantity threats analysis for the Township of Centre Wellington (report in progress). This analysis suggests that current agricultural water use does not have an adverse effect on the municipal water supply. An evaluation of the potential relative impact of municipal pumping on livestock groundwater demands was outside of the scope of the Tier Three Risk Assessment report and analysis of water quantity threats, and therefore was not evaluated.

5. Comment: *For planning purposes, it would also be more appropriate to re-word the recommendations and executive summary (vii) to show the needs for additional information should begin with the municipality obtaining additional data in their establishment of additional wells to satisfy long-term needs, followed by a repeat of the risk analysis study. Subsequent to that, other potential permit applicants could provide additional data if seeking a permit.*

   Response: Note that the numbering of the recommendations is not meant to infer a preferential order in which they should take place. There is currently no defined sequence for the order of future work.

6. Comment: *There should be a statement in recommendations that there is a risk that the model parameters may have to be revised as water taking proceeds for the larger population sizes expected, with that increased water taking being long-term over many years, especially if taken to 2041 or beyond.*

   Response: The Risk Assessment report (Matrix 2019; Recommendation #7) recommends regular updates of water budgets by the Grand River Conservation Authority. The modelling tools should be updated periodically as new information is gathered and insights evolve within the watersheds. The province already requires a municipality to complete the Tier Three scenarios as new wells are permitted to meet future water supply requirements.

7. Comment: *As a small point, is the number in Table 14 of Industrial-Other a misprint? If not, a comment on this amount of use would be appropriate.*

   Response: The number is not a misprint. A more fulsome summary of the permitted and non-permitted takings is provided in the Characterization Report (Matrix 2017; Appendix A). Details for this specific permitted taking are provided in Section 3.3.5 of that report. This "Industrial-Other" Permit To Take Water is for a hydroelectric power generator with a permit to temporarily divert Grand River surface water through a turbine and return that same volume of water back to the Grand River. Therefore, while the reported permitted rate appears to be large, no water is considered lost in the diversion process.

2 CLOSING

If you have any questions regarding this letter, please contact David Van Vliet by phone at 519.400.3186 or by email at dvanvliet@matrix-solutions.com.

Yours truly,

MATRIX SOLUTIONS INC.

Jeffrey Melchin, M.Sc., P.Geo.
Hydrogeologist

David Van Vliet, M.A.Sc., P.Eng.
Vice President, Technical Practice Areas

VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	07-Feb-2020	Draft	23876-527-SOW_JWilton L 2020-02-07 draft V0.1.docx	Issued to client for review
V0.2	27-Feb-2020	Draft	23876-527-SOW_JWilton L 2020-02-27 draft V0.2.docx	Issued to client for review
V1.0	11-Mar-2020	Final	23876-527-SOW_JWilton L 2020-03-11 final V1.0.docx	Issued to client

REFERENCES

Matrix Solutions Inc. (Matrix). 2019. 'Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report'. Version 0.4. Draft prepared for Grand River Conservation Authority. Guelph, Ontario. November 2019.

Matrix Solutions Inc. (Matrix). 2018. *Assessment of Climate Change and Assessment of Water Quantity Threats in the IPZ-Q in Support of the Guelph-Guelph/Eramosa Water Quantity Policy Study*. Version 1.0. Prepared for Lake Erie Source Protection Region. Guelph, Ontario. November 2018.

Matrix Solutions Inc. (Matrix). 2017. *Centre Wellington Scoped Tier Three Water Budget Assessment, Physical Characterization Report*. Prepared for Grand River Conservation Authority. Guelph, Ontario. December 2017.

Centre Wellington Tier Three Water budget Draft Final Risk Assessment Report, November, 2019

Questions and Comments related to the Risk Assessment Report

Overall, several points stand out with regard to this Nov. 2019 Risk Assessment Report. It is not what was expected. It does not take future population growth into account. It does not take future drought or climate change into account with the planned growth numbers. The Risk Assessment process is not finished. A further Risk Assessment is required after all future well locations have been established with testing.

1. **This assessment does not consider projected population growth to 2041.**

The rationale for initiating the Tier 3 was to determine the impact of doubling Centre Wellington's urban population by 2041.

This assessment ends at 2026 when the Township's current water infrastructure reaches capacity. The only future growth considered is growth that has been committed based on estimated available capacity.

Planned growth targets (i.e. projected growth to 2041) are not the basis of any conclusions of this study and this fact should be clearly stated in the Executive Summary and in the Introduction.

Recommended: It should be clearly stated in the introduction to the report and in the Executive Summary that this study does not consider the 2041 population growth targets for Centre Wellington.

2. **The 2026 cut off date is not what was expected with this project**. This fact is puzzling in light of the report's Introductory statement: "*The Tier Three Water Budget Assessment is required under the rules of the Clean Water Act (Bill 43, Government of Ontario 2017a) in the Province of Ontario to assess the sustainability of the municipality's water supply source in regards to meeting future population growth*" (p. 1)

It is contrary to information provided to CLG members and Council that Tier 3s look at growth scenarios and long-term planning.

It is contrary to the Tier 3 Terms of Reference, "*The water budget study...uses water budget tools to evaluate how water levels will change within the municipal wells **under various current and future scenarios**."* (p. 1).

It is contrary to the Physical Characterization Report, *"The Scoped Tier Three Assessment will assess the current and future stresses on municipal drinking water sources under current and future conditions."* (ES. p. iii)

And contrary to the Executive Summary of the Flow Model Report," *The model ...will be applied in later stages of the project to assess changes in water levels at municipal wells due to changes in municipal demand, land development and climate variability.*

Recommend: The assessment define its use of the term "future" within the context of the expectations of the Province's 2017 Technical Rules under the Clean Water Act.

3. <u>There are contradictions in what the assessment claims to do.</u> Page 5 states, "*Future municipal water projections were developed as part of the WSMP that are now available to assess within the Risk Assessment scenarios."*

Which contradicts page 32, "*The infrastructure required to meet the water demands associated with the projected population growth to 2041 (Table 7) has not been identified within a completed Master Plan or Class EA, and therefore no planned demands were included in this assessment."*

Recommend: In both the Executive Summary and the Introduction, clearly explain what specifically this assessment is doing.

4. <u>Is an additional risk assessment for projected growth planned and who will pay</u>? Originally, this Tier 3 was "Scoped" because the township did not have a Water Supply Master Plan. Given the fact a draft WSMP exists and Matrix has run scenarios through their model evaluating the future locations for four additional municipal wells, this assessment should not be scoped. The Tier 3 assessment of these potential well locations was released in a letter to AECOM dated April 2019.

Recommend: Include the April 19, 2019 Matrix Tier 3 assessment letter in this report as an Appendix.

Page 32 states, "*Risk Assessment scenarios capturing Planned demands may be evaluated using the Tier Three model when these locations are tested."* **This means we will need another Risk Assessment for these wells.** The question is, **who will pay for this next required Risk Assessment**? The initial model development costs were substantial. Going forward who will pay for the updates (Province, County, Township)?

5. <u>A substantial increase in water supply is required to meet 2041 demands</u>. "*Centre Wellington's service population will grow from 19,000 in 2016 to more than 40,000 people in 2041"*. (p. 1) Furthermore, the serviced population will expand beyond 40,000 to account for some of the one in seven public well owners within the urban boundary who will switch to municipal service.

Accordingly, the municipal water system must prepare to increase its average day water use from 5,103 m3/day in 2018 (p. 31) to over 11,709 m3/day by 2041 (p. 31-2). **This is an increase of 130% in 23 years**.

Why are we not considering the increased water service requirements in this risk assessment?

6. <u>Maximum day demands will exceed peak water supply capacity in 2026</u>. A statement below Table 7 states: "*Based on the projected population growth and a max day ratio of 1.75, the current permitted capacity (15,031 m3/d) will be exceeded for max day demand by 2031.*" This statement is misleading since the point of this report and the WSMP is **that the current wells cannot reach the PTTW**. The current well and pump infrastructure simply cannot do it.

The Water supply Master Plan Draft Final makes it very clear that the township will be in a deficit situation in 2026. (WSMP Draft Final, Executive Summary p. ii, table 1). This is without considering Firm Capacity. The attached figure from the WSMP (Draft Final p. vi) shows that in fact Maximum Day Demands meet Current Firm Capacity in 2019.

Recommend: that this sentence on page 32 be changed to read "*Based on the projected population growth and a max day ratio of 1.75, the current peak capacity (12,420 m3/d) will be exceeded for max day demand in 2026.*"

7. <u>This Risk Assessment is an evaluation of the sustainability of the current water system.</u> This report, which assesses risk based on a timeframe until well supply capacity is reached, is an extremely short time period in water management planning. For all purposes, this is an assessment of the current water system and the status quo.

This is not helpful, when Centre Wellington in 2018 had 42 residential developments in various stages of being plans, registered plans, approved developments and developments under construction.

Recommend: that the Executive Summary and Introduction state this assessment only evaluates until system capacity is reached in the next six years and not to 2041.

8. <u>The terms "allocated and planned" in this report are misleading</u>. The scenarios in sections 4 – 4.2.4 using the words "allocated + planned" are misleading. David van Vliet of Matrix explained at the end of the Nov. 18 CLG meeting that the term "allocated + planned' in Tables 3, 4 and 10 is there to satisfy 2017 Technical Rules under the Clean Water Act requirements. The Executive Summary defines "Allocated" as (Existing plus Committed demands up to the current permitted water takings", or to 15,060 m3/day.

Not until page 30 do we realize that "Allocated" for the purposes of this report only, refers to the timeframe of the existing total well system capacity, or 9,060 m3/day, and that a "Planned" demand does not exist for this study.

Recommend: that the report clearly defines the terms Existing, Committed, Allocated and Planned as they are used in this report in the introductory pages.

Under the Technical Rules, "Allocated demand" is defined as the *'existing demand' plus the "committed demand.*" (p. 30). Unfortunately any information relevant to "committed demand" is missing in this report.

9. <u>The term "committed demand" in this document is also misleading</u>. The Technical Rules definition of "committed demand" is *"the amount greater than the existing demand that is necessary to meet the needs of the **approved** settlement area within an Official Plan."* However, this study defines "committed demand" as the amount left over when you subtract the existing average daily water use from the total well system capacity.

Under the Technical Rules definition, what we are looking for with "committed demand" is the water needs of the **approved but not yet constructed developments.** It is important to know the future committed draws from our water system so we know the volume of water supply capacity remains.

This may not be the intended use of the term 'committed demand', but with the lack of numbers, it is hard to know. In any case, it is worth understanding the volume already 'committed' to developments.

Why was the actual "committed demand" as per the technical rules definition not used with this study?

10. <u>What is the Township's commitment for future water supply?</u> The assessment does not reveal the number of committed future housing units used in the assessment related to "Allocated demand" (Existing plus Committed demands). How many units does it take to exceed the current well capacity?

In November 2018 approved but not yet constructed development was estimated at 2,094 household units. (Hunter Report, Tables 6.4.1 and 6.4.2) **This number of units requires a water supply of 1,446 m3/day.** This does not include industrial or commercial development such as for the casino.

11. <u>The Township's current allocated demand is very close to exceeding supply on maximum days.</u> Although Tier 3 Risk Assessments look at averages, the Water Supply Master Plan identified a greater concern when applying maximum day demand to peak water supply capacity rather than applying average day demand to average day supply.

The WSMP concluded that capacity would be exceeded by demand in the year 2026, after which we would be in a deficit for peak day use (e.g. a serious water main break).

Table 7 of this Risk Assessment report provides the maximum day demand in 5-year increments from 2011 to 2041, but not the peak capacity numbers. These peak capacity numbers are noted in the Water Supply Master Plan draft final report, Table 1 'Future Water Supply Requirements'.

Recommend: Table 7 includes the infrastructure capacity necessary to meet the water demands associated with population growth to 2041.

In 2018 the township had a peak day capacity of 12,420 m3/day. For planning purposes this would be a firm wellfield capacity of 11,960 m3/day assuming the largest well out of service in the event of well maintenance or a contamination event. From this firm capacity, subtracting the 2018 maximum day demand (10,282 m3/day) as well as commitments for approved but not yet constructed residential developments (1,446 m3/day) the Township has only 232 m3/day of water supply capacity remaining.

Had the long-term watermain leaks in Elora not been repaired in March, 2018, the township would be in a deficit.

Have any developments been approved since November 2018? What are the new demand numbers for expanded commercial and industrial projects, such as for the casino?

It makes sense that this risk assessment assumes that Centre Wellington's water supply is already 100% allocated.

Recommend: clearly stating that the reason for re-defining "Allocated demand" as the same volume as System Capacity is because for planning purposes the water supply capacity is already 100% allocated.

12. <u>There is no Planned demand for Centre Wellington, since this would be above the system capacity.</u>

Recommend: On page vii, please remove the word 'likely' in this sentence:" the water supply infrastructure cannot *likely* meet the future needs of the municipality."

13. <u>Centre Wellington's water supply system is at significant risk</u>. This report states the appropriate conclusion that "Centre Wellington's current water supply system does not have the ability to meet future demands and this elevates the Water Quantity Risk Level to Significant for the Groundwater Vulnerable Area."

Given our "significant risk" status, the Township should reconsider approving any further developments before adopting a long-range implementation plan for its future water supply and before testing is carried out to ensure the plan is feasible.

14. <u>Elora's water supply is currently at more significant risk than Fergus'</u>. Elora's dependence on one well while its other two wells cannot simultaneously pump to their full capacity places it at great risk than Fergus. Equally concerning is the fact that the Aboyne Booster delivering water between the two communities is manually operated and was not designed for continuous use (staff information supplied in an FOI).

This situation places Elora at a **more significant risk level** than the town of Fergus.

15<u>. We don't know the future extent and drawdown of the Vulnerable Area</u>. It is surprising on the Vulnerable Area Map, Figure 7, that we are not shown a drawdown of more than 5 metres. It is worthwhile to show the further drawdown closer to the municipal wells as well as the zero reference for this drawdown. It is certainly not to the original levels of the wells. It is equally worthwhile to know the drawdown in the potential future water areas, not simply in the whole WHPA-Q1.

The Vulnerable Area is associated with the existing water demand. We need to know the extent and drawdown with future population growth. We need a map corresponding to Figure 7 that shows drawdown with planned growth. The reader may wish to compare the Tier 3 Fig 7 map to Golder's (2013) Well Field Capacity Assessment Figures from 1.14 to Fig 1.18 for the inclusive and underlying assumptions of how the wellfield is drawn down with future growth.

Until this future drawdown is determined, we cannot assess the following statements.

16. <u>The following sentences require additional information:</u>

"*The presence of groundwater takings or recharge reduction activities within this area (WHPA-Q1) does not imply that they will threaten the reliability of the municipal water supply."* (section 7.1.1 p 39)

And this qualifier that appears on Figures 7 and 11: *Note: the Risk level Assignment to the Groundwater Vulnerable Area does not imply than an individual groundwater taking or recharge reduction activity within that area will threaten the reliability of the municipal water supply*.

These qualifiers are counter-intuitive, particularly given the conclusion that consumptive water takings are a Significant Threat. These statements are made without any consideration of the anticipated projected demand. Of course groundwater takings and

recharge reduction will reduce the other takings, but we do not know by how much. This has to be calculated. As they stand, without future drawdown information, these are not reasonable statements.

17. <u>This assessment does not predict future Impacts of recharge change, drought and climate change for the future.</u> The scenarios, using 'Allocated' as the timeframe, are only assessing impacts from recharge change and drought until 2026. This assessment did not look at climate factors, as stated on page 26, "*The projected effects related to climate change are not evaluated as part of this Tier 3 assessment; however, these effects will be evaluated and documented in a subsequent report*."

However, Table 15 (p. 50) estimates recharge reduction over 4.3 km^2 at a volume of about 1,300 m^3/day or the loss of an approximate equivalent of an existing well (see Table 6).

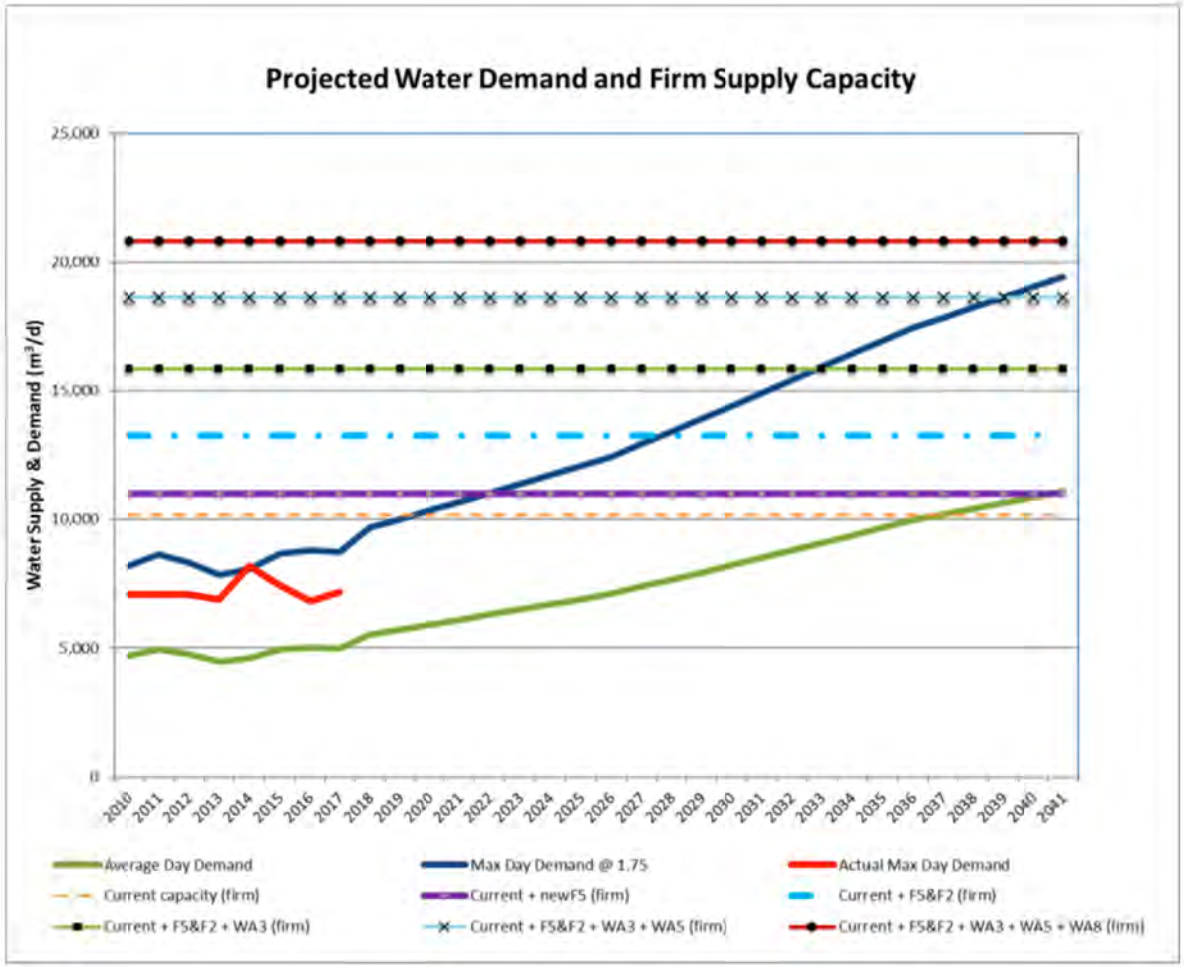
18. <u>Please clarify contradiction</u>. Pages 10 and 11 contain contradictions as quoted below. Clarification is required:

The results indicated that there is a lack of evidence to support a correlation between hydraulic conductivity and proximity to bedrock valleys. (section 2.4.3 p. 10)

Also higher conductivity was observed in areas where core samples showed a greater number of breaks that may be associated with stress relief zones associated with being closer to the Niagara Escarpment and bedrock valleys. (section 2.43 p. 11)

19. <u>Water quality at F6 should be mentioned in this report</u>. The report states on page 36: *Unlike other municipal wells except for F5, some of the most productive fractures within Well F6 occur at an elevation of 370 m asl (pg 36) or at only 54 m depth. This shallow depth explains in part the adverse water quality of this well.* Yet, the adverse quality of this water is not mentioned under water quality, on page 9. At F6, the TDS levels are always extremely high, around 1800 mg/L, but in April 2011 TDS were 2,020 mg/L, or 4 X the Drinking Water Objective of 500 mg/L, above which drinking water is considered unacceptable. This should be included under water quality data on page 9, and this well should be decommissioned, and if not it should be calculated that this well is utilized only on peak days.

Figure 2. Implementation of Water Supply Alternatives - Firm Capacity



Version 1.0
March 11, 2020 Matrix 23876-527

Ms. Sonja Strynatka
GRAND RIVER CONSERVATION AUTHORITY
400 Clyde Rd.
Cambridge, ON N1R 5W6

Subject: Response to Jan Beveridge (Save Our Water) Comments on the Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report

Dear Ms. Strynatka:

The purpose of this letter is to provide a response to Community Liaison Group (CLG) comments received from Jan Beveridge of Save Our Water received November 29, 2019 regarding the *Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report* (Tier Three Assessment; Matrix 2019).

1 RESPONSE TO SPECIFIC COMMENTS

1. Comment: *This assessment does not consider projected population growth to 2041.*

   The rationale for initiating the Tier 3 was to determine the impact of doubling Centre Wellington's urban population by 2041. This assessment ends at 2026 when the Township's current water infrastructure reaches capacity. The only future growth considered is growth that has been committed based on estimated available capacity.

   Planned growth targets (i.e. projected growth to 2041) are not the basis of any conclusions of this study and this fact should be clearly stated in the Executive Summary and in the Introduction.

   Recommended: It should be clearly stated in the introduction to the report and in the Executive Summary that this study does not consider the 2041 population growth targets for Centre Wellington.

   Response: Additional text has been added to the Executive Summary and Conclusions sections of the Risk Assessment report (Matrix 2019) clarifying that the Tier Three Assessment can only assess existing water supply wells or alternative wells that have already been tested and evaluated under a Master Plan or Class Environmental Assessment (EA) process. The existing municipal supply wells can only meet the municipality's average water demand until somewhere between 2031 and 2036. The *Township of Centre Wellington Water Supply Master Plan* (WSMP; AECOM 2019) evaluated alternatives to meet the 2041 population demand and outlined a process whereby the municipality will locate and test new water supply wells. However, the preliminary water supply alternatives considered in the WSMP cannot be assessed through the Tier Three Assessment until their respective sources are evaluated within a Master Plan or Class EA.

2. Comment: *The 2026 cut off date is not what was expected with this project. This fact is puzzling in light of the report's Introductory statement: "The Tier Three Water Budget Assessment is required under the rules of the Clean Water Act (Bill 43, Government of Ontario 2017a) in the Province of Ontario to assess the sustainability of the municipality's water supply source in regards to meeting future population growth" (p. 1)*

   It is contrary to information provided to CLG members and Council that Tier 3s look at growth scenarios and long-term planning.

   It is contrary to the Tier 3 Terms of Reference, "The water budget study...uses water budget tools to evaluate how water levels will change within the municipal wells under various current and future scenarios." (p. 1)

   It is contrary to the Physical Characterization Report, "The Scoped Tier Three Assessment will assess the current and future stresses on municipal drinking water sources under current and future conditions." (ES. p. iii).

   And contrary to the Executive Summary of the Flow Model Report," The model ...will be applied in later stages of the project to assess changes in water levels at municipal wells due to changes in municipal demand, land development and climate variability.

   Recommend: The assessment define its use of the term "future" within the context of the expectations of the Province's 2017 Technical Rules under the Clean Water Act.

   Response: The technical rules do not specify a year that each Tier Three Assessment must assess demands to. The term "future" is applied in the above examples to generally convey that the Tier Three Assessment assesses the impacts due to increased demand as the result of population growth. Indeed, the more specific terms which follow the expectation of the Technical Rules and relevant technical guidance are the concepts of "Committed", "Allocated", and "Planned" demand, which are defined in Section 5.2.1 of the Risk Assessment report (Matrix 2019).

3. Comment: *There are contradictions in what the assessment claims to do. Page 5 states, "Future municipal water projections were developed as part of the WSMP that are now available to assess within the Risk Assessment scenarios."*

   Which contradicts page 32, "The infrastructure required to meet the water demands associated with the projected population growth to 2041 (Table 7) has not been identified within a completed Master Plan or Class EA, and therefore no planned demands were included in this assessment."

   Recommend: In both the Executive Summary and the Introduction, clearly explain what specifically this assessment is doing.

   Response: Additional text has been added to the Executive Summary and Conclusions sections of the Risk Assessment report (Matrix 2019) clarifying the scope of the Tier Three Assessment.

4. Comment: *Is an additional risk assessment for projected growth planned and who will pay? Originally, this Tier 3 was "Scoped" because the township did not have a Water Supply Master Plan. Given the fact a draft WSMP exists and Matrix has run scenarios through their model evaluating the future locations for four additional municipal wells, this assessment should not be scoped. The Tier 3 assessment of these potential well locations was released in a letter to AECOM dated April 2019.*

   Recommend: Include the April 19, 2019 Matrix Tier 3 assessment letter in this report as an Appendix.

   Page 32 states, "Risk Assessment scenarios capturing Planned demands may be evaluated using the Tier Three model when these locations are tested." This means we will need another Risk Assessment for these wells. The question is, who will pay for this next required Risk Assessment? The initial model development costs were substantial. Going forward who will pay for the updates (Province, County, Township)?

   Response: This Tier Three Assessment was initiated in 2016 as a "scoped" study, because at that time long-term municipal demand projections were not available. As a result, only Risk Assessment scenarios that evaluated the impact of existing municipal demands could be evaluated. In 2018, Centre Wellington initiated a WSMP that is now substantially complete (AECOM 2019). Future municipal water demand projections were developed as part of the WSMP that became available to assess within the Risk Assessment scenarios. As a result, this Tier Three Assessment is no longer considered a scoped study. This discussion is provided in Section 1.3 of the Risk Assessment report (Matrix 2019).

   The April 19, 2019, Matrix letter was completed under the scope of work for the WSMP and not the Tier Three Assessment.

   Defining funding sources for future Tier Three Assessments is not within the scope of this report. As was stated in the November 18 CLG meeting, the municipality will always continue its work to secure a long-term reliable water supply. Much of the township's work is to service growth, and future water supply studies will be funded through development charges.

5. Comment: *A substantial increase in water supply is required to meet 2041 demands. "Centre Wellington's service population will grow from 19,000 in 2016 to more than 40,000 people in 2041". (p. 1) Furthermore, the serviced population will expand beyond 40,000 to account for some of the one in seven public well owners within the urban boundary who will switch to municipal service.*

   Accordingly, the municipal water system must prepare to increase its average day water use from 5,103 m^3/day in 2018 (p. 31) to over 11,709 m^3/day by 2041 (p. 31-2). This is an increase of 130% in 23 years.

   Why are we not considering the increased water service requirements in this risk assessment?

   Response: The Tier Three Assessment is limited to the evaluation of existing water supply wells and wells that have been tested and considered within a Master Plan or Class EA. It is the WSMP that evaluates alternatives to meet the increased water service requirements given the 2041 demands. Updates to the Source Protection Plan (i.e., updates to existing and new wellhead protection areas) will be required as the Township completes additional technical work and obtains permits and approvals for new water supply wells.

6. Comment: *Maximum day demands will exceed peak water supply capacity in 2026. A statement below Table 7 states: "Based on the projected population growth and a max day ratio of 1.75, the current permitted capacity (15,031 m^3/d) will be exceeded for max day demand by 2031." This statement is misleading since the point of this report and the WSMP is that the current wells cannot reach the PTTW. The current well and pump infrastructure simply cannot do it.*

   The Water supply Master Plan Draft Final makes it very clear that the township will be in a deficit situation in 2026. (WSMP Draft Final, Executive Summary p. ii, table 1). This is without considering Firm Capacity. The attached figure from the WSMP (Draft Final p. vi) shows that in fact Maximum Day Demands meet Current Firm Capacity in 2019.

   Recommend: that this sentence on page 32 be changed to read "Based on the projected population growth and a max day ratio of 1.75, the current peak capacity (12,420 m^3/d) will be exceeded for max day demand in 2026."

   Response: The text has been updated as follows: *"Based on the projected population growth and a max day ratio of 1.75, the current permitted capacity (15,031 m^3/d) will be exceeded for max day demand by 2031. The WSMP presents Seven Day and 30-Day Peak Capacities of 13,510 m^3/d and 12,410 m^3/d, respectively. The WSMP uses the Seven Day Peak Capacity as a basis for the implementation of additional water supply capacity projects to service future growth to 2041."*

   In 2020, the Township is proceeding with Optimization at Wells F2 and F5 and a groundwater exploration program in Areas 3, 5, and 8 to secure additional capacity.

7. Comment: *This Risk Assessment is an evaluation of the sustainability of the current water system. This report, which assesses risk based on a timeframe until well supply capacity is reached, is an extremely short time period in water management planning. For all purposes, this is an assessment of the current water system and the status quo.*

   This is not helpful, when Centre Wellington in 2018 had 42 residential developments in various stages of being plans, registered plans, approved developments and developments under construction.

   Recommend: that the Executive Summary and Introduction state this assessment only evaluates until system capacity is reached in the next six years and not to 2041.

   Response: Additional text has been added to the Executive Summary and Conclusions sections of the Risk Assessment report (Matrix 2019) clarifying the scope of the Tier Three Assessment.

8. Comment: *The terms "allocated and planned" in this report are misleading. The scenarios in sections 4 - 4.2.4 using the words "allocated + planned" are misleading. David van Vliet of Matrix explained at the end of the Nov. 18 CLG meeting that the term "allocated + planned' in Tables 3, 4 and 10 is there to satisfy 2017 Technical Rules under the Clean Water Act requirements. The Executive Summary defines "Allocated" as (Existing plus Committed demands up to the current permitted water takings", or to 15,060 m^3/day.*

   Not until page 30 do we realize that "Allocated" for the purposes of this report only, refers to the timeframe of the existing total well system capacity, or 9,060 m^3/day, and that a "Planned" demand does not exist for this study.

Recommend: that the report clearly defines the terms Existing, Committed, Allocated and Planned as they are used in this report in the introductory pages.

Under the Technical Rules, "Allocated demand" is defined as the 'existing demand' plus the "committed demand." (p. 30). Unfortunately any information relevant to "committed demand" is missing in this report.

Response: The definitions for Existing, Committed, Planned, and Allocated demand according to the Technical Rules and relevant technical guidance are provided in Section 5.2.1 of the report (Matrix 2019). The text in Section 5.2.1.2 was refined to improve clarity.

As stated in Section 5.2.1.2, the infrastructure required to meet the water demands associated with the full projected population growth to 2041 has not been identified within a completed Master Plan or Class EA, and therefore no Planned demands were included in this assessment.

9. Comment: *The term "committed demand" in this document is also misleading. The Technical Rules definition of "committed demand" is "the amount greater than the existing demand that is necessary to meet the needs of the approved settlement area within an Official Plan." However, this study defines "committed demand" as the amount left over when you subtract the existing average daily water use from the total well system capacity.*

   Under the Technical Rules definition, what we are looking for with "committed demand" is the water needs of the approved but not yet constructed developments. It is important to know the future committed draws from our water system so we know the volume of water supply capacity remains.

   This may not be the intended use of the term 'committed demand', but with the lack of numbers, it is hard to know. In any case, it is worth understanding the volume already 'committed' to developments.

   Why was the actual "committed demand" as per the technical rules definition not used with this study?

   Response: The definitions for Existing, Committed, Planned, and Allocated demand according to the Technical Rules and relevant technical guidance are provided in Section 5.2.1 of the report (Matrix 2019). The text in Section 5.2.1.2 was refined to improve clarity.

10. Comment: *What is the Township's commitment for future water supply? The assessment does not reveal the number of committed future housing units used in the assessment related to "Allocated demand" (Existing plus Committed demands). How many units does it take to exceed the current well capacity?*

    In November 2018 approved but not yet constructed development was estimated at 2,094 household units. (Hunter Report, Tables 6.4.1 and 6.4.2) This number of units requires a water supply of 1,446 m^3/day. This does not include industrial or commercial development such as for the casino.

    Response: As was stated in the November 18 CLG meeting, the municipality will always continue its work to secure a long-term reliable water supply. Much of the township's work is to service growth, and future water supply studies will be funded through development charges. The WSMP describes methods used to estimate future water supply requirements referenced in the Tier Three report.

11. Comment: *The Township's current allocated demand is very close to exceeding supply on maximum days. Although Tier 3 Risk Assessments look at averages, the Water Supply Master Plan identified a greater concern when applying maximum day demand to peak water supply capacity rather than applying average day demand to average day supply.*

    The WSMP concluded that capacity would be exceeded by demand in the year 2026, after which we would be in a deficit for peak day use (e.g. a serious water main break).

    Table 7 of this Risk Assessment report provides the maximum day demand in 5-year increments from 2011 to 2041, but not the peak capacity numbers. These peak capacity numbers are noted in the Water Supply Master Plan draft final report, Table 1 'Future Water Supply Requirements'.

    Recommend: Table 7 includes the infrastructure capacity necessary to meet the water demands associated with population growth to 2041.

    In 2018 the township had a peak day capacity of 12,420 m^3/day. For planning purposes this would be a firm wellfield capacity of 11,960 m^3/day assuming the largest well out of service in the event of well maintenance or a contamination event. From this firm capacity, subtracting the 2018 maximum day demand (10,282 m^3/day) as well as commitments for approved but not yet constructed residential developments (1,446 m^3/day) the Township has only 232 m^3/day of water supply capacity remaining.

    Had the long-term watermain leaks in Elora not been repaired in March, 2018, the township would be in a deficit.

    Have any developments been approved since November 2018? What are the new demand numbers for expanded commercial and industrial projects, such as for the casino?

    It makes sense that this risk assessment assumes that Centre Wellington's water supply is already 100% allocated.

    Recommend: clearly stating that the reason for re-defining "Allocated demand" as the same volume as System Capacity is because for planning purposes the water supply capacity is already 100% allocated.

    Response: Table 7 in the Risk Assessment (Matrix 2019) report has been updated to reflect the data in Table 1 of the WSMP. A footnote in the table now includes the current average annual and peak system capacity numbers from the WSMP. The Tier Three report has been updated to clarify the scope and assumptions used in the assessment. The remaining questions and comments are outside the scope of the Tier Three.

12. Comment: *There is no Planned demand for Centre Wellington, since this would be above the system capacity.*

    Recommend: On page vii, please remove the word 'likely' in this sentence:" the water supply infrastructure cannot likely meet the future needs of the municipality."

    Response: The text has been updated as suggested.

13. Comment: *Centre Wellington's water supply system is at significant risk. This report states the appropriate conclusion that "Centre Wellington's current water supply system does not have the ability to meet future demands and this elevates the Water Quantity Risk Level to Significant for the Groundwater Vulnerable Area."*

    Given our "significant risk" status, the Township should reconsider approving any further developments before adopting a long-range implementation plan for its future water supply and before testing is carried out to ensure the plan is feasible.

    Response: We cannot address this recommendation within the scope of the Tier Three Assessment report.

14. Comment: *Elora's water supply is currently at more significant risk than Fergus'. Elora's dependence on one well while its other two wells cannot simultaneously pump to their full capacity places it at great risk than Fergus. Equally concerning is the fact that the Aboyne Booster delivering water between the two communities is manually operated and was not designed for continuous use (staff information supplied in an FOI).*

    This situation places Elora at a more significant risk level than the town of Fergus.

    Response: Fergus and Elora have an integrated water distribution system, and as a result, water can be transferred between the two communities. As a result, the Significant risk classification applies to both communities.

15. Comment: *We don't know the future extent and drawdown of the Vulnerable Area. It is surprising on the Vulnerable Area Map, Figure 7, that we are not shown a drawdown of more than 5 metres. It is worthwhile to show the further drawdown closer to the municipal wells as well as the zero reference for this drawdown. It is certainly not to the original levels of the wells. It is equally worthwhile to know the drawdown in the potential future water areas, not simply in the whole WHPA-Q1.*

    The Vulnerable Area is associated with the existing water demand. We need to know the extent and drawdown with future population growth. We need a map corresponding to Figure 7 that shows drawdown with planned growth. The reader may wish to compare the Tier 3 Fig 7 map to Golder's (2013) Well Field Capacity Assessment Figures from 1.14 to Fig 1.18 for the inclusive and underlying assumptions of how the wellfield is drawn down with future growth.

    Until this future drawdown is determined, we cannot assess the following statements.

    Response: It is recognized that predicted aquifer drawdown in the municipal wells is greater than 5 metres and this is reflected in the chart and table of simulated groundwater level decline for the Tier Three scenarios (i.e., Chart 1 and Table 10 of the Risk Assessment report [Matrix 2019]). Matrix has chosen to show the 5 metre drawdown area as it reflects the drawdown across much of the area of the pumping wells. An illustration of a zero reference for drawdown is not appropriate given the approach taken.

The WHPA-Q1 (Vulnerable Area) represents drawdown considering future population growth. More specifically, the WHPA-Q1 represents the 2 m composite drawdown contour of a scenario where the Centre Wellington municipal wells pump at their future (Allocated) rates and non-municipal wells pump at their current rates. Additional detail about the WHPA-Q1 is provided in sections 4.1.1 and 7.1.1 of the Tier Three Assessment report (Matrix 2019).

16. Comment: *The following sentences require additional information:*

    "The presence of groundwater takings or recharge reduction activities within this area (WHPA-Q1) does not imply that they will threaten the reliability of the municipal water supply." (section 7.1.1 p 39)

    And this qualifier that appears on Figures 7 and 11: Note: the Risk level Assignment to the Groundwater Vulnerable Area does not imply than an individual groundwater taking or recharge reduction activity within that area will threaten the reliability of the municipal water supply.

    These qualifiers are counter-intuitive, particularly given the conclusion that consumptive water takings are a Significant Threat. These statements are made without any consideration of the anticipated projected demand. Of course groundwater takings and recharge reduction will reduce the other takings, but we do not know by how much. This has to be calculated. As they stand, without future drawdown information, these are not reasonable statements.

    Response: The identification of "Significant" Threats within a WHPA-Q1 that has been assigned a Significant Risk Level represents an initial screening-level exercise. When designing the Tier Three Assessment, the province made a decision to be conservative when initially identifying threats and has additional steps in the process to prioritize these threats based on potential effects to the municipal supply wells. After the Tier Three Assessment, additional work will be completed to rank these threats based on their effects on the municipal water supply. The relative impact of consumptive water takings and areas where future land development may reduce groundwater recharge will be assessed in greater detail as part of a preliminary water quantity threats analysis that is in progress for the Township of Centre Wellington.

17. Comment: *This assessment does not predict future Impacts of recharge change, drought and climate change for the future. The scenarios, using 'Allocated' as the timeframe, are only assessing impacts from recharge change and drought until 2026. This assessment did not look at climate factors, as stated on page 26, "The projected effects related to climate change are not evaluated as part of this Tier 3 assessment; however, these effects will be evaluated and documented in a subsequent report."*

    However, Table 15 (p. 50) estimates recharge reduction over 4.3 km^2 at a volume of about 1,300 m^3/day or the loss of an approximate equivalent of an existing well (see Table 6).

    Response: Table 4 in the Risk Assessment report (Matrix 2019) summarizes the various scenarios that were run using the groundwater flow model to predict potential impacts to water levels at the existing municipal wells. These scenarios included assessment of the relative impacts of:

    1) Decreased recharge due to future land use change according to the Official Plan (i.e., due to an increase in impervious surfaces).

2) Increased municipal pumping due to population growth (i.e., future demands representing the estimated average annual capacity of the existing water supply system that is approximately equivalent to the projected future average demands between 2031 and 2036).

3) Two periods of drought within an existing 45-year climate record.

The magnitude of the simulated groundwater level decline resulting from these scenarios can be found on Table 10 and graphically on Chart 1. A climate change assessment is being completed and a report will be made available in 2020.

18. Comment: *Please clarify contradiction. Pages 10 and 11 contain contradictions as quoted below. Clarification is required:*

The results indicated that there is a lack of evidence to support a correlation between hydraulic conductivity and proximity to bedrock valleys. (section 2.4.3 p. 10)

Also higher conductivity was observed in areas where core samples showed a greater number of breaks that may be associated with stress relief zones associated with being closer to the Niagara Escarpment and bedrock valleys. (section 2.43 p. 11)

Response: Thank you for identifying this. The second paragraph of Section 2.4.3 has been revised to better reflect the main findings of the article:

> *The study results also indicated that there may be a combination of geological controls that together may be influencing the hydraulic conductivity trends of different areas. For example, relatively higher hydraulic conductivity values coincided with areas where the Gasport Formation was sub-cropping/outcropping; therefore, carbonate dissolution may have been enhanced in these areas due to a greater amount of vertical recharge. While a higher hydraulic conductivity was not found to be explicitly correlated with the proximity to buried valleys, deep bedrock valleys and frequent jointing and fracturing found in areas with relatively higher hydraulic conductivity were interpreted to provide conduits for enhanced dissolution.*

19. Comment: *Water quality at F6 should be mentioned in this report. The report states on page 36: Unlike other municipal wells except for F5, some of the most productive fractures within Well F6 occur at an elevation of 370 m asl (pg 36) or at only 54 m depth. This shallow depth explains in part the adverse water quality of this well. Yet, the adverse quality of this water is not mentioned under water quality, on page 9. At F6, the TDS levels are always extremely high, around 1800 mg/L, but in April 2011 TDS were 2,020 mg/L, or 4 X the Drinking Water Objective of 500 mg/L, above which drinking water is considered unacceptable. This should be included under water quality data on page 9, and this well should be decommissioned, and if not it should be calculated that this well is utilized only on peak days.*

Response: Water quality concentration trends in the municipal wells were reviewed as part of the characterization phase of the Tier Three Assessment (i.e., Section 4.2 of Characterization Report [Matrix 2017]), primarily to help shed light on the source of the water (e.g., shallow vs. deep). However, detailed analyses of water quality were outside the scope of this study and were not completed or reported. In-depth analysis of water quality concerns is provided in water quality threats assessments under the Clean Water Act where potential drinking water quality Activities, Conditions and Issues are identified that could pose a threat to the quality of a municipal drinking water supply.

2 CLOSING

If you have any questions regarding this letter, please contact David Van Vliet by phone at 519.400.3186 or by email at dvanvliet@matrix-solutions.com.

Yours truly,

MATRIX SOLUTIONS INC.

Jeffrey Melchin, M.Sc., P.Geo.
Hydrogeologist

David Van Vliet, M.A.Sc., P.Eng.
Vice President, Technical Practice Areas

VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	07-Feb-2020	Draft	23876-527 SOW_JBeveridge L 2020-02-07 draft V0.1.docx	Issued to client for review
V0.2	27-Feb-2020	Draft	23876-527 SOW_JBeveridge L 2020-02-27 draft V0.2.docx	Issued to client for review
V0.3	11-Mar-2020	Final	23876-527 SOW_JBeveridge L 2020-03-11 final V1.0.docx	Issued to client

REFERENCES

AECOM Canada Ltd. (AECOM). 2019. 'Township of Centre Wellington, Water Supply Master Plan'. Draft prepared for The Township of Centre Wellington. Kitchener, Ontario`. July 2019.

Matrix Solutions Inc. (Matrix). 2019. 'Centre Wellington Tier Three Water Budget Draft Final Risk Assessment Report'. Version 0.4. Draft prepared for Grand River Conservation Authority. Guelph, Ontario. November 2019.

Matrix Solutions Inc. (Matrix). 2017. *Centre Wellington Scoped Tier Three Water Budget Assessment, Physical Characterization Report*. Prepared for Grand River Conservation Authority. Guelph, Ontario. December 2017.